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ABSTRACT

Since 1985 the American Association for the Advancement of Science (AAAS) has supported Project 2061, a long-term effort to improve education in science, mathematics, and technology. This document is the report of a year-long evaluation of Project 2061 conducted from fall 1995 to fall 1996. The evaluation focused on the impacts that two major documents produced by the Project--"Science for All Americans" and "Benchmarks for Science Literacy" have had on science education. In addition, the evaluation reports on the impacts of Project 2061-sponsored workshops targeting teachers, teacher leaders, and teacher educators. Chapter II focuses particularly on publications on people and practices at the national level. In Chapter III, the focus is on the impacts of Project 2061 in the states and includes impacts at the local level. Chapter IV focuses on the workshops that Project 2061 has conducted, particularly those workshops conducted for teachers, Project 2061's designated teacher leaders, and teacher educators. Chapter V synthesizes the information from the earlier chapters into a set of conclusions based on all the data collected and analyzed for the evaluation. In addition, a set of recommendations is provided to Project 2061 for future strategies that can extend and elaborate on its work to date. An attachment to volume I describes the methodology used for the evaluation. Appendices in volume II include: Case Study Findings for Colorado, Georgia, New Jersey, New York, South Carolina, and Wyoming; findings from an assessment of the quality of textbooks; a list of curriculum frameworks examined for the evaluation of Project 2061; and mail surveys for Project 2061 workshop participants. (JRH)

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Evaluation of the American Association for the Advancement of Science's Project 2061

Volume I: Technical Report

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EXECUTIVE SUMMARY

This is a report of a year-long evaluation of Project 2061 conducted from Fall 1995 to Fall 1996 by SRI International. The evaluation focuses on the impacts of key Project 2061 documents on science education, as well as the impacts of Project 2061-sponsored workshops targeting teachers, teacher leaders, and teacher educators.

The Impacts of Project 2061 Documents at the National Level

Project 2061 has been successful at the national level in many ways. Notably, Project 2061 played a major role in the development of the *National Science Education Standards* (*NSES*). The influence of *Science for All Americans* (*SFAA*) and *Benchmarks for Science Literacy* on the *NSES* is one of the Project's most significant contributions.

Several federal agency programs begun in the early 1990s and predicated on theories of standards-based reform explicitly encouraged applicants at the state and local levels to align themselves with *Science for All Americans* and/or *Benchmarks for Science Literacy*, thereby increasing the "market" for Project 2061's ideas. Other national organizations independently have integrated the use of Project 2061 documents into their programs, including the Association for Supervision and Curriculum Development and the National Science Teachers Association.

Virtually all the nation's leading science educators believe that Project 2061 has been a positive force for improving science education. Nonetheless, some question one or another tenet, such as the salience of any national reform documents for teachers' daily concerns and classroom practice or the feasibility of having all students achieve the standards described in *Benchmarks*.

One audience with heavy national influence, textbook publishers, has yet to subscribe fully to Project 2061's vision of science literacy. Despite a recognition that Project 2061 and other national reform documents are calling for reduced content and different approaches to teaching than in the past, publishers have made only incremental changes, layered on top of existing textbook formats and content.

Taken as a whole, the evidence of Project 2061's broad influence demonstrates its positive contribution to the national climate for science education reform. The core concepts of Project 2061's vision for science literacy were derived from concepts in different stages of development and originating among different groups. Project 2061 wove these concepts together into one coherent, comprehensive, compelling vision of

science literacy and disseminated the unified vision to a greater number of communities and audiences than ever before. Importantly, the documents it has published show what the scientific community believes students should know about science.

The Impacts of Project 2061 Documents in the States

The Perceptions of State Science Education Leaders

Forty telephone interviews were conducted with state science supervisors, leaders of NSTA-affiliated state professional associations, and curriculum framework writers from 27 different states. A remarkably high percentage (90%) of the state leaders who were interviewed indicated they currently use or refer to *Benchmarks* in their day-to-day work, and nearly two-thirds (64%) indicated that they use *Science for All Americans*.

Over 80% of the state leaders said Project 2061 had played a major role in defining scientific literacy in their respective states. Many also believe that Project 2061 influenced the science education reform strategy in their states. The most influential aspects of Project 2061's strategy were judged to be that the "benchmarks" were for all students, that there should be grade-specific goals predicated on research, that defining specific outcome goals is an important first reform step, that science is best learned through performing science, and that Project 2061 tools can aid local curriculum development.

Impacts of Project 2061 on State Curriculum Frameworks

Within the theory of systemic reform, curriculum frameworks are expected to guide state policies as well as teacher practice. Curriculum frameworks therefore represent a reasonable leverage point for Project 2061. A reading of 43 state curriculum framework (or other standards-type) documents showed that, overall, such documents do exhibit evidence of influence from Project 2061, as apparent in bibliographic references to *SFAA* and *Benchmarks*, quotations establishing science literacy visions, and organizational schemas similar to that of Project 2061.

In addition, an expert group of 20 distinguished science and mathematics educators was convened to review 12 recently completed science and mathematics curriculum frameworks (of which 6 were in science) produced under a federal math and science frameworks development program. The reviewers found that the frameworks reflect national standards documents, including *Benchmarks for Science Literacy*. However, framework documents rarely treat equally the full range of concepts found in *Benchmarks*, and the reviewers found that some documents simplified the concepts found in *Benchmarks*, while others diluted them.

Evidence from case studies conducted in six states (Colorado, Georgia, New Jersey, New York, South Carolina, and Wyoming) consistently supported the finding that the greatest influence of Project 2061 in the states has been on the development of state and district curriculum frameworks. Among the six case study states, four made direct use of Project 2061 documents in putting together their state-level frameworks or standards.

Impacts on Other State Policies and Practices

There are many other state policies that could be influenced by Project 2061. However, politics, including controversies about curriculum frameworks and such hot-button topics as human evolution, is a common barrier to Project 2061's having a stronger influence in states. For example, attempts to change the way that states assess students' learning is a long, difficult, expensive, and often politically charged process. When assessments are not aligned with reform efforts, as in Georgia and New York, teachers may feel that they must spend a lot of time preparing students for "basic skills" tests.

Professional development can help teachers to put standards and frameworks to use in their classrooms. Five of the six case study states have made use of Project 2061 documents in large-scale professional development activities, such as those that are linked to systemic change projects (called Statewide Systemic Initiatives) sponsored by the National Science Foundation.

Perceptions of Project 2061 and the *National Science Education Standards*

When asked whether they "see any important differences between the *NSES* and *Benchmarks* in terms of their respective visions for science education reform and definitions of science literacy," almost all interviewees, including 81% of the state leaders surveyed, responded that there are no differences or only minor ones. They believe that the content standards overlap greatly and, where they do not, that they enhance each other in important ways. However, there is some concern that competition between the national documents will weaken the coalition for a single set of science education goals and standards, and there is also concern about fragmentation of the science disciplines.

Many of the people interviewed for this evaluation believe that teachers will use other documents, such as state and district curriculum frameworks, much more often than any of the national documents. State teacher association leaders and the teachers themselves are most concerned about the usability of national reform documents by rank-and-file teachers. Nonetheless, about half of the interviewees believe that the

development of national science education standards will have greater impact on science education than the mathematics standards have had in that discipline.

Project 2061 Workshops

Project 2061 developed, tried out, and revised a variety of workshops with the dual purpose of informing key audiences and learning from them. Three separate groups were identified as especially important participants in workshop activities since September 1994: teachers, teacher leaders (members of the Project 2061 Leaders Network), and preservice teacher educators. Mail surveys from more than 180 participants in Project 2061 workshops were analyzed.

Results of the Teacher and Teacher Leader Surveys

An examination of the teachers' and the leaders' backgrounds demonstrates that they are above-average teachers. The teacher respondents indicated two main reasons for attending a workshop: they were involved in curriculum development or were particularly interested in learning about Project 2061. The leaders had more varied reasons for attending, of which the most common was that they had been invited by Project 2061.

The great majority of the leaders (74%) found the workshop of significant or major benefit to their work, whereas only about a third (36%) of the teachers held the same opinion. One probable explanation of this difference is that teachers did not perceive a very strong linkage of the workshop ideas to classroom practice. Still, when asked only about increasing their familiarity with Project 2061, the vast majority of both teachers and leaders agreed that what they learned was beneficial.

The workshops clearly conveyed many main ideas of Project 2061 to both teachers and leaders, but more successfully with the leaders than with other teachers. However, relatively few teachers strongly agreed with some central reform ideas, such as "less is more" or that science education reform should be driven by learning goals.

In some areas, teachers who attended the workshops did report a modest amount of change in teaching practices. For example, an additional 8% of the teachers reported that they used student discussion and inquiry in almost every class after the workshops. However, much larger percentages of the leaders reported that they changed classroom practices after the workshops.

A high percentage of the leaders reported that they have engaged in training others, and two-thirds of the leaders planned to conduct additional training sessions in the future.

Nonetheless, the number of training sessions per leader per year is relatively low, and the leaders believe they are an untapped resource for their districts and for Project 2061.

Results of the Teacher Educator Survey

The great majority of participants work at institutions of higher education, where approximately equal numbers are on the education faculty and in science departments. There were three main reasons for attending the workshop: they were invited to attend; they worked on an education reform project; and they wanted to improve preservice teacher education.

Nearly half of the teacher educators found the workshops to be of significant or major benefit to their work. Increasing their familiarity with the ideas of Project 2061 was considered an important benefit, as was the opportunity to discuss science education reform with colleagues from many backgrounds. The participants largely agreed with the core ideas of Project 2061. Most of these respondents make use of *Science for All Americans* (92%) and *Benchmarks for Science Literacy* (90%). The *National Science Education Standards* (89%) and a variety of other documents are also heavily used.

Reflections and Recommendations

During its first 10 years, Project 2061 has been highly productive. Thus, leaders of the Project are faced with the question of what initiatives in the future would continue to make a significant contribution to science education reform. Some of the evaluation findings may prove useful to inform those choices.

Among the key national groups identified for the evaluation, those that developed the *National Science Education Standards* and others developing state curriculum frameworks have used the documents most extensively. Science curriculum materials developers have made far less constructive use of the documents, to date. At the local level, there is some direct use of Project 2061 documents (for example, several districts in Georgia use *Benchmarks* to assist in selecting textbooks). However, the evaluation data show that serious constraints govern the process of systemic reform in the states.

These findings suggest that, having made a major impact on science standards and frameworks, Project 2061 now may constructively focus on other components of the education system where progress is needed. Systems for assessing students' learning and for developing (and adopting) science instructional materials are examples.

Future Project 2061 initiatives might also be designed in light of the skepticism of teachers and certain leadership groups, notably leaders of state science teacher professional organizations. It appears that the closer the groups are to the classroom, the less likely they are to know how to use the Project 2061 documents well.

Assessing Future Initiatives for Project 2061

On the basis of the evaluation findings, seven criteria are proposed by which to judge whether initiatives would be suitable to be conducted by Project 2061:

- Address problem areas where the opportunities are great.
- Make use of the scientific and educational expertise of AAAS.
- Be well matched to the amount of resources (budget and staff) available.
- Make use of, and leverage, existing networks working in science education reform.
- Be designed to survive political realities at the state and federal levels.
- Be consistent, and be *perceived* as consistent, with the *National Science Education Standards*.
- Build on the successes of *Science for All Americans* and *Benchmarks for Science Literacy*.

Combining these criteria with reflections on the evaluation findings leads to three main options recommended for consideration as future Project 2061 initiatives:

1. Carry out further work on key components of standards-based reform. Particularly productive opportunities may exist for Project 2061 to focus on textbooks and other instructional materials, or on assessments of student learning. A variety of tools might be produced, such as a means of analyzing assessments (similar to the curriculum analysis tool under development).

2. Use other leverage points in the K-12 education system. Project 2061 might profitably work with selected professional networks, even assigning a half-time staff member to act as a liaison with such groups. School districts, particularly urban districts, may also be a key entry point for the Project. Also, alliances with projects creating new technology tools for teachers and students may prove useful, as the impact of technology on education continues to grow.

3. Focus on the undergraduate level. Undergraduate education has a significant influence on elementary and secondary schools. Project 2061 might address issues of science literacy at the undergraduate level—e.g., by extending *Benchmarks* to that level.

I. INTRODUCTION: AN EVALUATION OF PROJECT 2061

This is a report of a year-long evaluation of Project 2061 conducted from Fall 1995 to Fall 1996 by SRI International. The evaluation focuses on the impacts that two major documents produced by the Project—*Science for All Americans* and *Benchmarks for Science Literacy*—have had on science education and on science educators. In addition, the evaluation reports on the impacts of Project 2061-sponsored workshops targeting teachers, teacher leaders, and teacher educators.

Project 2061

Since 1985, the American Association for the Advancement of Science (AAAS) has supported Project 2061, a long-term effort to improve education in science, mathematics, and technology. The name of the project stems from the fact that Halley's Comet, which was visible in 1985, will not return to the vicinity of the earth until the year 2061. The originators of Project 2061 believed that because the reform of mathematics, science, and technology education in the United States will take decades, naming the project with the date of the comet's return would be an appropriate reminder of the long-term nature of the change process.

The first major product of Project 2061 was *Science for All Americans*, a comprehensive definition of science literacy that identifies what all high school graduates should know and be able to do in order to be literate in science. The definition of science literacy is broad, including not only connections among the natural and social sciences, mathematics, and technology, but also connections with the arts, humanities, and vocational subjects. *Science for All Americans* was produced by Project 2061's staff, an advisory board, and five panels consisting principally of scientists, mathematicians, and engineers. More than 100,000 copies have been sold since it was first published in 1989, after 4 years of work.

In 1993, Project 2061 published *Benchmarks for Science Literacy*, which provides more specific recommendations concerning the learning goals, or benchmarks, to be

achieved by students at the end of grades 2, 5, 8, and 12. Although no particular curriculum or curriculum design is implied by *Benchmarks*, the document is intended to be useful as a tool for curriculum designers, state education agency staff, teachers, and other educators. *Benchmarks for Science Literacy* was written by Project 2061 staff with assistance from an advisory committee (the National Council on Science and Technology Education) and a large number of teachers, school administrators, scientists, mathematicians, and others. More than 70,000 copies are in circulation. An electronic version of *Benchmarks for Science Literacy*, called *Benchmarks on Disk*, was published in 1994.

Project 2061 is now in the process of publishing a series of other tools, including *Resources for Science Literacy: Professional Development* and *Resources for Science Literacy: Curriculum Materials*, both of which will be available on CD-ROM, with accompanying print materials. Project 2061 staff continue to believe that science, mathematics, and technology education reform is intrinsically a long-term operation, and that reform requires the development of a variety of new tools and their thoughtful use by thousands of educators and others interested in improving education.

Project 2061 has been operating during a unique period in the history of American education. The first education summit of the Governors, held in 1989, focused the attention of state and national leaders on the importance of high academic standards for all students. The National Education Goals adopted by the Governors, and since then endorsed by Congress and the President, are predicated on the development of rigorous academic standards for students. This evaluation documents the fact that Project 2061 has contributed in significant ways to the development of such standards, particularly for science education.

The Evaluation

In 1995, AAAS commissioned SRI International and its subcontractor, Inverness Research Associates, to conduct a year-long evaluation of Project 2061.[1] In consultation with Project 2061, the evaluation staff developed four primary research questions to guide the evaluation:

(1) To what extent have three key audiences (national reformers, state science curriculum framework developers, and science curriculum materials developers) made use of *Benchmarks for Science Literacy* and *Science for All Americans*?

(2) How is Project 2061 actually used by the audiences identified above, as well as by a group of secondary audiences (e.g., state science supervisors, leaders of state professional associations for science teachers)?

(3) What are the impacts of Project 2061 workshops on several groups of participants: teachers, teacher leaders, and teacher educators?

(4) Through what set of strategies could Project 2061 increase its impact on the educational system?

The questions are linked to one another in various ways. In particular, questions relating to the extent of use of Project 2061 materials and the particular nature of that use are intertwined. Also, considerations of Project 2061's future strategy depend in part on answers to the other three research questions.[2]

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[1] Inverness Research Associates conducted two of the six case studies (South Carolina and Wyoming). This evaluation was also able to fruitfully leverage two other evaluations that SRI International is conducting [the national evaluation of the National Science Foundation's Statewide Systemic Initiatives (SSI) program, and an evaluation of the Eisenhower State Curriculum Frameworks Projects, supported by the U.S. Department of Education], as well as the Council of Chief State School Officers' 50-state framework project. In particular, the Project 2061 case study site visits were conducted in conjunction with those for the SSI evaluation, and the expert review of curriculum frameworks and science textbooks for Project 2061 was a joint effort with the Eisenhower State Curriculum Frameworks Projects evaluation and CCSSO's 50-state framework project.

[2] Project 2061 has also operated six regional centers at the district level that incorporate the work of elementary, middle, and high school teachers. However, this evaluation was designed to focus only on the impacts of Project 2061 documents and Project 2061-sponsored workshops. Also, the evaluation was not designed to address current efforts; however, recommendations in the last chapter are presented in the context of Project 2061 activities that are already under way.

To answer these questions, five major data collection strategies have been used:

- **Expert interviews.** Interviews were conducted with approximately two dozen experts in science education, most of whom are federal officials, scholars, leading state officials, and directors of national associations. In addition, interviews were conducted with science editors from a few major publishing companies and with individuals working for "alternative" (nonprofit) curriculum developers.
- **Document review.** The evaluation team examined a large sample of state science curriculum frameworks. Expert reviewers assessed a subset of the frameworks and two elementary science and two secondary biology textbooks. In addition, other publications important to science education reform, such as *National Science Education Standards*, were reviewed.
- **Telephone surveys.** Semistructured telephone surveys were conducted with key state leaders: science supervisors, state professional association leaders, and others involved in developing curriculum frameworks. Compared with the expert interviews, these surveys were designed to yield more uniform data and responses that could be more easily tabulated.
- **Mail surveys.** Participants in Project 2061 workshops were surveyed by mail. For purposes of the evaluation, the key audiences for the workshops were defined as teachers, Project 2061's designated teacher leaders, and teacher educators.
- **Case studies.** Site visits were conducted in six states to gather information about the impact of Project 2061 at the state and local levels. The states are identified in Table 1. Two separate criteria were used to select the states: (1) states where little or no reform activity was under way were not selected because it was expected that little pertinent to this evaluation would be learned; and (2) states were chosen that vary in the locus of control for educational decision-making.

More information about the methodology of the evaluation can be found in Attachment A.

The Structure of This Report

The next section of this report (Chapter II) focuses on the impacts of Project 2061's work, particularly its two major publications, on people and practices at the national level, which is the first place that the influence of Project 2061 would be expected.

In Chapter III, the focus is on the impacts of Project 2061 in the states. This chapter includes impacts at the local level, as well; however, because of the staged nature of

much reform activity—national, then state, and then local—one might reasonably expect to see fewer impacts at the local level at this time.

Table 1
CASE STUDY SAMPLE

State	Activities in Science Education Reform	Locus of Control
Colorado	SSI; local standards development under way	Local control
New York	SSI; Eisenhower curriculum framework grant; active reform agenda	Mixed
New Jersey	SSI; Eisenhower curriculum framework grant	Local control tradition, but new state standards now emerging
Georgia	SSI; standards-based reform state; site of 2061 center	State control, although recently some local
South Carolina	SSI; draft standards and framework under review	State control
Wyoming	Professional development emphasis	Local control, no official standards or framework

Chapter IV focuses on the workshops that Project 2061 has conducted, particularly those workshops conducted for teachers, Project 2061's designated teacher leaders, and teacher educators. The teacher leaders are a group of 69 individuals from 22 states who have been trained by Project 2061 in part for the purpose of providing workshops about *Benchmarks for Science Literacy*. Project 2061 also has given special attention to working with teacher educators who are involved in the preservice preparation of teachers.

Chapter V synthesizes the information in the earlier chapters into a set of conclusions based on all the data collected and analyzed for the evaluation. In addition, a set of recommendations is provided to Project 2061 for future strategies that can extend and elaborate on its work to date.

II. THE IMPACTS OF PROJECT 2061 DOCUMENTS AT THE NATIONAL LEVEL

Project 2061 has created a vision of science literacy that has been influential at the national level in many ways. Throughout this evaluation, evidence will testify to Project 2061's significant impact not only at the national level, but also at the state and, to a lesser extent, local levels of the education system. These findings provide an occasion to reflect on Project 2061's achievements to date in promoting its vision of science literacy, as well as an opportunity to raise questions about Project 2061's future priorities and allocation of resources. At many points in the report, implications of the evaluation findings for Project 2061's future options will be raised, culminating in a set of recommendations presented in the final chapter.

This chapter will document the many instances of Project 2061's broad and substantive impact that together demonstrate how Project 2061 has changed the terms of the national discussion on science education reform. One criterion for assessing Project 2061's influence is its "reach" across different agencies and institutions, and the breadth of such influence at the national level is documented in this chapter. First, the report traces Project 2061's impacts on the new *National Science Education Standards*. Next, impacts on federal agencies and national organizations are discussed. Results of an examination of Project 2061's impacts on textbooks and other science instructional materials follow. This chapter concludes with a discussion of how Project 2061 has influenced the national climate for science education reform.

Project 2061 and the National Science Education Standards

In 1989 Project 2061 published *Science for All Americans*, and two other events occurred that accelerated the movement to develop voluntary national standards in education. In that year, the nation's Governors, meeting in Charlottesville, Virginia, adopted a set of national education goals promoting "world-class" standards for all students. In addition, the National Council of Teachers of Mathematics (NCTM)

published its *Curriculum and Evaluation Standards for School Mathematics*, the first discipline-based set of national standards developed and published for American schools.

From that point on, it was only a matter of time before the other disciplines taught in grades kindergarten through 12 published their own standards. The U.S. Department of Education began to support the development of science standards in 1991, providing funding to the National Academy of Sciences' National Research Council (NRC). In December 1995, after many drafts had been circulated and thousands of comments on the drafts had been collected and analyzed, the *National Science Education Standards* (*NSES*) were finally published by the NRC.

Project 2061 has played a major role in the development of the *NSES*. Dr. James Rutherford, the Director of Project 2061, was appointed to the Chair's Advisory Committee to assist in its creation, and the introduction to the *National Science Education Standards* further states:

> The many individuals who developed the content standards sections of the *National Science Education Standards* made independent use and interpretation of the statements of what all students should know and be able to do that are published in *Science for All Americans* and *Benchmarks for Science Literacy*. The National Research Council of the National Academy of Sciences gratefully acknowledges its indebtedness to the seminal work by the American Association for the Advancement of Science's Project 2061 and believes that use of *Benchmarks for Science Literacy* by state framework committees, school and school-district curriculum committees, and developers of instructional and assessment materials complies fully with the spirit of the content standards.

Benchmarks was published in 1993, several years before the science standards, and well in advance of release of the first "predraft" of the *NSES* (May 1994). Although some short-term confusion may arise from the coexistence of what intended users generally perceive to be two sets of "national standards" (discussed in Chapter III), a comparison of the content standards section of the *National Science Education Standards* and *Benchmarks for Science Literacy* highlights the overlap in content of the two documents. Some interviewees, such as state science supervisors, have estimated the overlap in content at 85% to 90%. The *Summary Comparison of Content between the November*

draft of National Science Education Standards and Benchmarks for Science Literacy (Project 2061, 1995) concludes that "given the vast intellectual territory at stake, what is most impressive is the great similarity between the content of the two versions, not their differences" (p. 9).

The importance of Project 2061's contribution to the development of the *National Science Education Standards* can also be judged by the comments of those who played important roles in developing the latter document. One member of the NRC standards development team said, "Project 2061 was a considerable help and an important part of the development of the standards." This person estimated that "there is probably a 90% plus overlap in the content" between the *NSES* and *Benchmarks for Science Literacy*. Another member of the development team reported that "Project 2061 served as the NRC's conscience. We knew that whatever we wrote would be compared to their work and scrutinized by their staff. We knew it would have to be of the highest quality, focused on equity, and decidedly non-elitist."

The *National Science Education Standards* have been well received and, because standards-based reform continues to be important in so many states and localities (see Chapter III), science standards are likely to have considerable influence in the United States. If they are anything like the NCTM mathematics standards, one can expect the *NSES* to remain in their current form, or something close to it, for at least 10 years, and probably much longer.

For these reasons, the impact of Project 2061 on the development of the *National Science Education Standards* must be considered one of its major contributions to date. As the nation sought to identify ambitious learning goals for students, *Science for All Americans* and *Benchmarks for Science Literacy* were produced at the right time, with the right set of messages, and were sponsored by the right group (an organization representing dozens of scientific societies) to be broadly recognized as authoritative, timely, and useful steps toward national science education standards.

With their publication, *Benchmarks* and the *NSES* became resources in the public domain that worked in concert with other national reform efforts. The next section outlines Project 2061's influence on national reform efforts that federal agencies initiated.

Impacts on Federal Agencies

Ever since the early 1980s, the federal government and many state governments have been interested in raising standards for student achievement. *A Nation At Risk*, written by the U.S. Department of Education's National Commission on Excellence in Education, was published in 1983, and it became one of the most persuasive federal documents calling for higher standards. In the same year, the National Science Board (NSB) Commission on Precollege Education in Mathematics, Science and Technology published *Educating Americans for the 21st Century*, which proposed a plan "for all American elementary and secondary students so that their achievement is the best in the world by 1995." The NSB Commission's call for action was later repeated in the National Education Goals promulgated by the Governors in 1989 (although the year 2000 was substituted for 1995), and the goals were codified into federal law as part of the Goals 2000 legislation.

With both the National Science Foundation and the U.S. Department of Education pressing for higher standards during the late 1980s and into the 1990s, the most prominent federal agencies active in education were poised to support emerging national (not federal) standards for mathematics and science education as soon as they were written and published (assuming that the documents were perceived as representing high quality and reflected a broad consensus of opinion). The climate for federal government acceptance of documents such as *Science for All Americans* and *Benchmarks for Science Literacy* was thus a very receptive one. The nation was hungry for ambitious national standards, particularly in mathematics and science—subjects that have been viewed at least since the Sputnik era as central to the nation's economic self-interest.

One result has been that both the National Science Foundation and the U.S. Department of Education urged states and local districts to incorporate or demonstrate

consistency with Project 2061's vision of science literacy in their proposals for important federal initiatives. In the case of the National Science Foundation, a new federal program that began in 1990, the Statewide Systemic Initiatives (SSI) Program, represented a significant departure from past Foundation practices of awarding modest-sized grants to universities to help promote K-12 education reform. By contrast, SSI awards were for up to $10 million and 5 years, and required that the proposed program establish new partnerships (typically involving government, private agencies, and institutions) in the participating states.

The SSI program was the first federal program to be based on theories of "systemic" or "standards-based" reform. These theories assume that a cornerstone of reform is that states and districts will develop and adopt ambitious standards for what students should know and be able to do. The SSI program explicitly supported *Science for All Americans* as a useful model to be considered by those states supporting a systemic initiative in elementary and secondary science education (see Exhibit 1). Furthermore, research conducted for this evaluation shows that Project 2061 has, indeed, been used by SSI states in ways envisioned by federal policy-makers (see Chapter III for a discussion and examples).

Similar to NSF, the U.S. Department of Education has referred to Project 2061 as a model to support standards-based or systemic reform. Beginning in 1992, the Department used an existing federal program, the national portion of the Eisenhower Mathematics and Science Education Program, to promote the development and implementation of state curriculum frameworks in mathematics and science. Again, *Science for All Americans* is noted as one of a very small number of documents that could serve as a foundation on which the states applying for federal funds could build their frameworks (see Exhibit 1). And again, as with the SSI program, this evaluation has gathered evidence showing that states have, indeed, used Project 2061 products to develop their state curriculum frameworks (see Chapter III).

These are not the only examples of federal agencies endorsing Project 2061 work. However, these are important citations because these programs were early examples of

federal agencies relying on a standards-based approach to education reform, an approach that fits so well with the efforts and products of Project 2061. Subsequently, a number of other federal programs (including the U.S. Department of Education's Goals 2000 and NSF's Collaboratives for Excellence in Teacher Preparation) have also referred to standards-based reform in mathematics and science, thereby enlarging the "market" for Project 2061's ideas.

Exhibit 1

REFERENCES TO PROJECT 2061 IN SELECTED FEDERAL PROGRAM SOLICITATIONS

Among the reports by national study groups that should be considered seriously by any organization preparing a proposal under this solicitation are...*Project 2061—Science for All Americans* (American Association for the Advancement of Science). Among the important features of certain of these reports are their outlines of the knowledge and skills that every student should command....

Statewide Systemic Initiatives in Science, Mathematics, and Engineering Education: NSF Program Solicitation (1990)

Frameworks must build upon...science standards emerging from major curriculum reform projects, such as the National Science Teachers Association's *Scope, Sequence, and Coordination* project, the American Association for the Advancement of Science's *Project 2061—Science for All Americans*, and the work of...the National Academy of Sciences.

Dwight D. Eisenhower National Program for Mathematics and Science Education—State Curriculum Frameworks for Mathematics and Science:
U.S. Department of Education Notice of Final Priority (July 1992)

Project 2061 and National Organizations

In addition to these prominent federal agencies, the diversity of national organizations reporting use of Project 2061 is further testament to the widespread reach that Project 2061 has achieved at the national level. Examples of such organizations and brief descriptions of how they make use of Project 2061 documents follow:

- The **National Science Teachers Association** (NSTA) has recently signed a joint statement with the National Academy of Sciences and the American Association for the Advancement of Science (Project 2061) expressing a "shared vision of science education reform" and indicating that the three organizations intend to cooperate to bring it about.
- The **New Standards Project**, a partnership of states and urban school districts that is developing a new kind of assessment system to gauge student progress toward meeting high standards, made use of Project 2061's work in developing draft performance standards for students in science.
- A national membership organization for practicing educators, the **Association for Supervision and Curriculum Development** (ASCD), distributes a series of videotapes entitled *Science Standards: Making Them Work for You*, which offer "a realistic view of how teachers apply the *Benchmarks for Science Literacy*."
- ***The Technology Teacher*** has published an article called "Defining the field of technology education," which states that *Benchmarks* identifies "appropriate technology content" and provides a range of useful principles regarding both the selection of content and the ways it should be taught. Because national standards for technology education are under development, *Benchmarks* may have some influence on them through this exposure.
- The **National Center for Supercomputing Applications** (NCSA), at the University of Illinois, has had support from the National Science Foundation to conduct national workshops for science teachers, and asks that teachers use *Science for All Americans* and *Benchmarks* as the basis of the curriculum work they are assigned to do in the workshops.

This list is by no means comprehensive, nor does it gauge the degree of impact in each case, but it does illustrate the breadth of Project 2061's impacts nationwide. The fact that such a remarkably diverse set of influential organizations has made use of Project 2061 documents, typically as a starting point for dealing with issues related to science literacy, is evidence that Project 2061 has had broad national influence.

In contrast to the influence on such organizations, the next section presents the relatively limited impact of Project 2061 and other science reform efforts on another important national resource, commercial textbooks.

The Impacts of Project 2061 on Science Textbooks

Although the education system in the United States is largely decentralized, instructional materials for teaching science are produced and distributed by an industry that is national in scope and highly influential in what and how science is taught. For this reason, it is important to understand the impacts, and potential impacts, of Project 2061 on instructional materials, especially textbooks.

The Importance of Textbooks

According to *The 1993 Survey of Science and Mathematics Education* (Horizon Research, 1995), 72% of classes in grades 1-4 use commercially published textbooks, increasing to 91% in grades 5-8 and to 97% in grades 9-12. When teachers use them, the great majority cover more than 50% of the commercial textbook or program. Moreover, a majority of teachers appear comfortable with the quality of the textbooks they use. Sixty-three percent of teachers of science in grades 1-4 rated their textbooks "good," "very good," or "excellent," as did 69% of grades 5-8 teachers and 80% of grades 9-12 teachers.

Market share, and thus influence, is concentrated, with only a few publishers selling a majority of the textbooks:

- Three publishers account for 72% of the market share for science textbooks in grades 1-4.
- Five publishers, each with more than 10% market share, have a total concentration of nearly 80% in grades 5-8.
- The three largest publishers together account for 56% of texts used in grades 9-12.

Publishers are well aware of this extended reach into the classroom. One editor boasted, "We have more influence on teachers than AAAS will ever have." Any future mergers similar in scope to Addison-Wesley's recent acquisition of Scott Foresman will only further concentrate classroom influence into fewer hands in the publishing industry.

Project 2061's Influence on Commercial Textbooks: Expert Review

To evaluate the extent of Project 2061's influence on recent textbooks, a group of science education experts was convened. The group examined sections of four recent science textbooks: two elementary texts (dated 1994 and 1996), and two secondary biology books (published in 1995 and 1996). (See Volume 2, Appendix B, for more information.)

Elementary textbooks. In the elementary books that the experts examined, introductory passages describe the national reform effort and name specific efforts, particularly *Science for All Americans*, *Benchmarks for Science Literacy*, *National Science Education Standards*, and *The Content Core: Scope, Sequence, and Coordination*. Textbooks quote *Science for All Americans* (*SFAA*) to illustrate the meaning of science literacy, including the key ideas that all students should learn science, that science is a natural endeavor, and that science knowledge and scientific thinking are applicable to social and personal purposes.

The reviewers found that the greatest changes reside in the annotated teacher's guide rather than within the body of the student text. The teacher's guides provide some useful suggestions for incorporating aspects of science literacy that are consistent with Project 2061's vision, such as elaborations on historical episodes in science, as well as strategies for linking science, technology, and society issues in the curriculum. However, because many of these notes appear only in the teacher's guides, it is quite easy for the teacher to skip them and for the student to lose exposure to these enrichments. Furthermore, the group felt that although these notes addressed topics and issues that characterize Project 2061, many examples were superficial.

The experts also noted that textbooks provide suggestions for new pedagogical approaches (as described in Chapter 13 of *Science for All Americans*, "Effective Learning and Teaching") but do not consistently build such approaches into the student text. For example, *SFAA* states that students learn to do well what they practice doing. *SFAA* also advocates that teaching should be consistent with the nature of scientific inquiry,

including questioning and solving problems through the collection and use of evidence and having students "offer their own interpretations of what the evidence means" (p. 201).

By contrast, publishers cite a greater number of lab experiments as one significant change in instructional materials, but the reviewers found that the lab activities are seldom inquiry based, providing instead exact procedures for students to follow and answers for them to confirm. In one elementary text, experimental skills were not integrated into the other content chapters but were simply added as a separate chapter, in direct contradiction to *SFAA*'s recommendation to "not separate knowing from finding out" (p. 202).

Secondary textbooks. Many of the comments made about elementary textbooks apply to secondary texts, as well. To make the analysis of two secondary texts manageable, experts reviewed selected chapters on evolution and introductory and pedagogical notes to the teacher in the annotated teacher's guide, rather than the entire lengthy text.

Although the chapters on evolution were well written, the experts criticized their organization. The reviewers argued that an understanding of inquiry-based teaching (as consistent with Project 2061 ideas of effective teaching) and of the scientific method suggests that the exploration of evidence should come first, from which conclusions are then drawn. However, the textbooks, while presenting much of the available evidence on evolution, present the theory first as a statement of fact, rather than allowing students to draw conclusions based on the evidence presented. The evidence is available, but it is not marshaled in a compelling fashion consistent with the nature of science or with good pedagogy. The experts declared that "the limited approach [and] scattering of ideas ignores all we know about teaching it.... The text does little to dispel Lamarckian misconceptions.... The text does not give problems to use the main ideas [and is] careless with wording that might be easily misconstrued."

When the expert reviewers examined the content of the chapters and compared it with relevant sections of *Benchmarks for Science Literacy*, they found only partial correspondence with the appropriate benchmarks, belying the simplistic matrices publishers create to list the benchmarks ostensibly covered in each chapter. The breadth and detail of the material comprising the textbook ultimately obfuscate major concepts. For example, neither chapter clearly explains or demonstrates that the concept of variation within species, which is then subject to natural selection, is the crucial concept of evolution. *Benchmarks* states:

> Natural selection provides the following mechanism for evolution: Some variation in heritable characteristics exists within every species, some of these characteristics give individuals an advantage over others in surviving and reproducing, and the advantaged offspring, in turn, are more likely than others to survive and reproduce. The proportion of individuals that have advantageous characteristics will increase. (5F, 9-12, #3)

The reviewers commented, "This is at the heart of evolution, but it is just passed over. There is not enough emphasis on variation within species." This concept is presented with the same amount of emphasis as that allotted to all other topics.

In general, the reviewers felt that the range and type of topics covered are essentially the same as those covered 10 years ago. Voluminous biology texts reflect the organization of high schools around science disciplines. Technical vocabulary abounds (in each case, the glossaries contain about 1,000 technical terms that are used in the body of the book), and authors have not eliminated material extraneous to what is required to meaningfully convey key concepts. Material that is either developmentally inappropriate, according to *Benchmarks*, or simply excessive is pervasive and detracts from the main concepts. The reviewers noted that not only are the textbooks "designed to cover the standards, [they] cover everything."

From the Publishers' Point of View

To discover how Project 2061 documents might influence publishers during the textbook development cycle, interviews were conducted with a number of science education editors. None of them believe that science content has changed greatly over the

past 10 years. Rather, the presentation is different, with more color and graphics, and new features that provide approaches for diverse populations and social issues. Publishers tend to place new technological formats (including videodiscs and CD-ROMs) at the top of their priority list, rather than a rethinking of what is included in the textbook.

Market forces determine textbook publishers' decisions in virtually all respects. Textbook publishing is characterized by high initial investments, and profitability is contingent on achieving large economies of scale. In efforts to maximize market share, the large publishers are motivated to appeal to as many people as possible. (Smaller, "niche" publishers believe they have more latitude to innovate.) They must meet textbook adoption criteria and time their publishing cycles to the adoption cycle. According to publishers, two "adoption states," California and Texas, alone represent 50% of all textbook sales.

To protect their competitive position, publishers are not willing to align textbooks with reforms that a majority of teachers have not fully accepted. One product manager believes that "teachers, for the most part, blur these reform ideas. They are more concerned about their own accountability to the principal, district, or state." Another editor believes that teachers are waiting to see whether the reform ideas will endure and, in the meantime, are merely paying lip service to the *NSES* and Project 2061.

At the same time, publishers feel that they cannot afford to completely ignore Project 2061 and the *NSES*, in case teachers are eventually held accountable for using state standards based on them. Publishers hedge, holding on to what is traditional as the basis of the book, and append or integrate some of the new ideas, but only to the extent that they do not risk rejection by teachers.

Publishers admit that texts continue to be laden with superfluous details because "Even though people ask for 'less is more,' when they go to make their decision, they want everything.... From a business point of view, we can't make the decision to cut content. Every state looks at content differently...to cut content would be financial suicide." Publishers have made some changes, but they are incremental, layered on top of

existing textbook formats and content. The changes do not fundamentally distinguish new textbooks from traditional ones; furthermore, because they are incremental, the changes are not entirely consistent with the vision of science literacy promulgated by Project 2061.

Interviews with publishers reveal that dialogue between reformers and publishers is scarce to nonexistent, and publishers further believe that reformers perceive them as "pariahs" of the education system. These conditions are not conducive to a good partnership. One editor suggested that a relatively simple gesture, such as providing publishers with *Benchmarks on Disk*, would not only facilitate the use of this document but would strengthen relationships with Project 2061. The publishers have little external motivation to take on what they perceive as greater business risk in order to be aligned with reform documents that, according to them, have not taken hold within the teaching community—at least at this point in time.

The publishing industry holds substantial influence over teachers, and therefore is one potentially important channel Project 2061 should consider to achieve changes in classroom practice. Chapter V explores ways that Project 2061 might fruitfully work with publishers in the future.

Dissenters

When commercial publishers express their unwillingness to risk fully assimilating Project 2061's vision of science literacy, they are partially validated by the skepticism of some other national science reformers. Despite the broad-based acceptance found in this evaluation, it was not surprising to uncover such skepticism because Project 2061 did not purport to represent a "consensus" view. Three of the more common reasons for disagreements are reported below. Understanding why people hold these views is useful, even though those reporting them are a minority of the leaders who were interviewed.

"Science as inquiry" is a shorthand way of describing the importance of teaching science as a way of knowing about the world, a disciplined inquiry into nature. Project 2061's publications make it clear that active learning and inquiry are important to

teaching and learning (and inquiry is even more strongly emphasized in the *NSES*). However, some leaders see a dilemma in advocating inquiry while simultaneously providing lengthy lists of benchmarks. There is a fear that the benchmarks will become topics to be checked off by teachers, or by publishers of tests and textbooks, rather than act as vehicles for focusing instruction and increasing students' understanding of science.

A different set of concerns has to do with the place of standards or benchmarks of any kind. "What are we supposed to do with these documents?" asked one well-known science educator, who felt that the needed revisions to curriculum, instruction, and assessment might or might not be forthcoming, but would not necessarily follow on the heels of nationally recognized documents, such as *Benchmarks*. Another science educator, who herself actively promotes reform, when asked what difference it would make if *Science for All Americans* and *Benchmarks* did not exist, said, "None!" She is concerned that these and other, related documents are too distant from the everyday concerns and needs of teachers and students.

A related opinion articulated by a few leaders interviewed for the evaluation is that the vision expressed in these documents is not achievable. One science teacher, who had taught in a ghetto environment and who now holds a position of leadership in a state teachers' organization, said of Project 2061 that "It sounds like it would be utopia if you could accomplish the different things they describe...it's a nice education philosophy, but not doable." This criticism parallels remarks made by expert reviewers that many states' curriculum frameworks have adopted Project 2061's emphasis on science "for all" but that a simple endorsement of "equity" says far too little about how equity can be achieved.

It is not surprising to find leaders who hold such views. Standards-based reform that begins with developing a set of ambitious goals for what students should know and be able to do is a very rational theory of change. However, the political and educational systems operate in ways that are not always describable as rational, with time horizons that often respond to short-term election cycles and headlines. It requires a certain degree of faith to set out on a journey as long as the one envisioned by Project 2061.

However, it is surprising to find that the dissenters are nearly always supporters, as well. These are people who agree, by and large, that Project 2061 is a step in the right direction and that, as one of them said, "It is better to light a candle than to curse the darkness—even if it is a small candle." Their skepticism is useful in that it raises important questions about the difficulties of creating a bridge between national efforts to establish standards and actual classroom implementation. Project 2061 needs to carefully consider options for reaching classrooms and pursuing strategies that address the concerns these reformers raise if they wish ultimately to influence classroom practice (further discussed in Chapter V).

Project 2061 and the National Climate for Science Education Reform

Taken together, the organizations discussed above contribute and respond to the national debate on science education reform. Their decisions reflect the direction of the debate and serve, in some sense, as a barometer of the concepts supported by the larger scientific and science education community. That Project 2061 influenced their decisions is an indication of Project 2061's influence on the national climate for science reform. Indeed, the leaders of Project 2061 have always had in mind a long-term agenda that includes "setting the terms of the discourse" in science education (Rutherford, 1995).

According to many leaders in science education interviewed for this evaluation (some of whom have been active for 30 years or more), *Science for All Americans* and *Benchmarks* clearly expressed several important strands of thinking that, although not necessarily original with Project 2061, required repetition, elaboration, and a source of authority in order to be incorporated into discourse among mainstream education policy-makers. The following ideas are the prominent ones that recurred in interviews with leading reformers:

- The idea of science as a subject to be learned by *all* students (not just an elite).
- The importance of coherence in science programs (especially at the elementary level, where, as one respondent said, the earlier view was that "science is science," and it didn't matter what was taught, just how).

- The interrelation of science with other subjects, including mathematics, technology, and the social sciences (including what are often called science-technology-society issues).
- A shift away from the hierarchy of traditional science disciplines—for example, by including earth science as an important part of science literacy (and thus an integral component of high school science for all students).
- An understanding that active learning of science (including such techniques as hands-on labs and activities, cooperative groups, and the use by students of technological tools) is critical if students are to effectively develop their understanding of key scientific ideas.

These ideas alone do not define Project 2061, nor are these the only ideas about improving science education that needed to be reinforced when *Science for All Americans* arrived. Instead, respondents appear to be saying that these were some important aspects of a *zeitgeist* or spirit of reform that has been developing among science education leaders over a period of many years.

In writing *Science for All Americans*, Project 2061 wove leading concepts about what science to teach and how to teach it—all in different stages of development and sophistication—into a coherent, comprehensive, compelling vision of science literacy. It is significant to note that these concepts were not all fully developed before Project 2061, nor were all these concepts gaining currency in all science and science education communities. Although individual reformers and reform organizations may have been leaders in different aspects of science education reform, a comprehensive view encompassing the best thinking in all aspects of science education reform did not exist before the publication of *Science for All Americans*. Since then, *Science for All Americans* and *Benchmarks* have presented a unified vision of science literacy to a greater number of communities and audiences than ever before.

The fact that the science establishment, cutting across many disciplines of science, expressed these ideas in publications intended for widespread distribution is also important. The imprimatur of a prestigious scientific organization aided in legitimating to a wider public the recommendations contained in *SFAA*. As one district science

coordinator interviewed for this evaluation said, "The *science community* has come together to articulate what *the* major content pieces [should be]."

Project 2061 has done more than identify a core set of facts and concepts that the science community believes constitutes science literacy. *Science for All Americans,* from which *Benchmarks* derived its core concepts, established a convincing rationale for reform, as well as setting some specific goals and strategies for that reform. It provided a banner around which science education reformers could rally. By promulgating this compelling story, by developing and refining the best thinking in science education reform, and by widely promoting the documents in diverse science and education communities, Project 2061 has thus changed the national climate for science education reform, as demonstrated by the broad base of national organizations that have been influenced by its key publications.

These successes at the national level might be further leveraged in future initiatives, as consistent with the criteria for determining future strategies discussed in Chapter V. The question is also raised whether Project 2061 has been equally successful in the states; evidence about this issue is presented in the next chapter.

III. THE IMPACTS OF PROJECT 2061 DOCUMENTS IN THE STATES

The evidence presented in the preceding chapter demonstrates that Project 2061 has had a variety of strong, clear impacts at the national level. This chapter focuses on impacts of Project 2061 in the states, which is the level of government in the United States that has primary responsibility for managing and providing elementary and secondary education.

It is reasonable to expect that Project 2061 has had an influence in many states, because mathematics and science education have been federal priorities and, to some extent, national priorities for at least a decade.[3] There has also been pressure on states, exerted by Governors and others, to adopt standards-based reform. Still, one needs to ask whether Project 2061's key documents, among the many other potential influences, have actually been significant forces in states' efforts to improve science education.

To answer this question, the study team first interviewed three groups of education leaders at the state level to explore the extent and nature of use of Project 2061 documents. These groups are: state science supervisors, the directors or presidents of state affiliates of the National Science Teachers Association, and other individuals who were involved in writing state curriculum framework documents.

Next, the evaluation focused on the impacts of Project 2061 on state curriculum framework documents themselves. More than 40 such documents were reviewed, and an expert panel assessed in greater detail the quality of a smaller set of the frameworks. In addition, case studies were conducted in six states, including visits to local districts and to schools. These visits focused on impacts of Project 2061 at the state or local level, whether on curriculum frameworks or on other components of the education system.

The result is a body of evidence, derived from many sources, that bears on the central question: whether Project 2061 has had significant impacts in the states and, if so,

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[3] For example, Congress created the Eisenhower Mathematics and Science Education Program in 1984, and funding for the National Science Foundation's Education and Human Resources Directorate climbed steadily after 1984 for more than a decade.

how. The findings are organized and presented around four topics: impacts on state leaders, impacts on curriculum frameworks, impacts on other components of the education system, and reflections on perceived differences between *Benchmarks for Science Literacy* and the *National Science Education Standards.* Finally, a set of conclusions about impacts in the states synthesizes all of the findings.

The Perceptions of State Science Education Leaders

In addition to 6 case studies, 40 telephone interviews were conducted with state science supervisors, leaders of NSTA-affiliated state professional associations, and curriculum framework writers from 27 different states. The interviewers asked which sources of information have been most influential in the respondent's work, and those data are reported here. Information was also gathered about which sources of information were regarded as influencing science education throughout their respective states. Particular attention was paid to how Project 2061 has influenced the definition of science literacy and science education reform strategies in the states.

Which State Leaders Are Influenced by Project 2061?

The case studies demonstrated that one of the significant ways that Project 2061 has had an effect on education in some states is by strongly influencing a key player, or players, in that state's education system, as well as confirming that many state leaders make use of *Benchmarks* or *Science for All Americans* (discussed in following sections). Principal investigators for SSIs in both Colorado and Georgia are strong advocates of Project 2061, as are other key players in the state departments of education. The chair of the standards and framework committees in New Jersey is a vocal proponent of Project 2061. The former state math and science coordinator in Wyoming, who has considerable influence because of the state's small population and unique education situation, also is an advocate for the Project 2061 documents and philosophy (see Exhibit 2).[4] Besides these influential figures, Project 2061 also influences others in touch with the national scene: district science and math supervisors (especially where those positions are still

[4] Exhibits 2 through 7 provide brief summaries of the findings in each of the six case study states. Lengthier descriptions can be found in Volume 2, Appendix A.

prevalent in the state, as in New York and New Jersey) and leaders of local NSTA/NCTM affiliates (e.g., in Wyoming).

Exhibit 2

PROJECT 2061 IN WYOMING: ADVOCATES IN LEADERSHIP POSITIONS

In Wyoming, the major state leaders—the state's former coordinator for science and math, staff at the University of Wyoming, and leadership of the WCTM and WSTA—all have had close working relationships, and have created a close-knit, statewide community of science and math teachers. Although there is no official standards document or framework in Wyoming, the state leaders are familiar and comfortable with the majority of ideas in both *Benchmarks* and the NCTM Standards.

The locus of control in education is at the local level; consequently, no state tests in science or math and no statewide textbook adoption policy exist. For decades, individual districts, schools, and teachers have determined what and how to teach largely on their own, and reforms tend to happen in pockets of excellence throughout the state.

Professional development has been the main emphasis in science and math education in the state in recent years because of the strategic use of Eisenhower funds. Coupled with the vision endorsed by the state leaders, the influence of the national documents on teachers comes primarily through teachers' professional development experiences. The relatively large amount of Eisenhower funds, the small number of teachers in the state (who enjoy a favorable 15:1 student/teacher ratio), and the strong influence of the state math and science coordinator have helped create a vision of math and science teaching among many teachers that is consistent with *Benchmarks*, *NSES*, and the NCTM *Standards*. At the same time, there is little awareness among teachers of specific Project 2061 documents. Instead, reforms have relied on personal networks, moving directly from the national level to the teachers via professional organizations and professional development, and then from the teachers to the districts.

Primary Sources of Influence on State Leaders

Beyond the 6 case study states, interviews with the 40 state leaders indicated that a remarkably high percentage (90%) of them currently use or refer to *Benchmarks* in their day-to-day work, and nearly two-thirds (64%) indicated that they use *Science for All Americans* (see Table 2). *Benchmarks* was reportedly used more frequently than the

National Science Education Standards (90% versus 85%), and it was judged as slightly more influential: 3.3 versus 3.1, on a scale of 1 to 4. The *National Science Education Standards (NSES)* were mentioned spontaneously by more respondents than *Benchmarks* (see Table 3), but by exactly the same percentage of state leaders (80%) who spontaneously mentioned either *Benchmarks* or *Science for All Americans*. All three of these documents were widely used in the states, and were rated by the state leaders as "very influential" within the state (averaging at least a 3.0).

Other science education documents were found to be less influential than these three, as judged by the state leaders. Two documents from the National Science Teachers Association, *The Content Core: Scope, Sequence, and Coordination* and *A High School Framework for National Science Education Standards*, were used by 44% and 21% of the state leaders, respectively.[5] Frameworks from other states or previous state frameworks were used by about 40% of the respondents, and were most often influential in helping construct new or revised state frameworks. About a third of the state leaders spontaneously mentioned the NSTA, conferences, research journals/articles, and other state science supervisors as other important sources of information besides these documents. *Benchmarks on Disk*, although highly valued by a few, was not recognized at all by others, and was used by only 21% of the leaders. (Tables 2 and 3 provide more detailed information about the responses of the leaders.)

Other sources of influence frequently mentioned by the leaders were the Council of State Science Supervisors (CSSS), the U.S. Department of Education's Regional Education Laboratories and its Eisenhower Clearinghouse, the Council of Chief State School Officers (CCSSO), the Association for Supervision and Curriculum Development (as well as other associations and their professional journals, including *Phi Delta Kappan*), the National Center for Improving Science Education (NCISE), the New Standards

[5] A 1996 version of *A High School Framework for National Science Education Standards*, also published by the National Science Teachers Association, is called *A Framework for High School Science Education*.

Table 2

Use of and Degree of Influence of Certain Science Education Documents (n = 39)

Document	Percentage Using	Degree of Influence (1-4)
Benchmarks for Science Literacy	90%	3.3
National Science Education Standards	85%	3.1
Science for All Americans	64%	3.0
The Content Core: Scope, Sequence, and Coordination	44%	2.1
Frameworks and other documents from other states	41%	2.2
A previous science framework in the state	39%	2.4
A High School Framework for National Science Education Standards	21%	1.5
Benchmarks on Disk	21%	1.4

Table 3

Primary Sources of Information Mentioned Spontaneously (n = 40)

Source	Number (and Percent) of Respondents
National Science Education Standards	32 (80%)
Benchmarks for Science Literacy	29 (73%)
Science for All Americans	16 (40%)
National Science Teachers Association	13 (33%)
Conferences	13 (33%)
Research journals/articles	13 (33%)
(Other) State science supervisors	12 (30%)
The Content Core: Scope, Sequence, and Coordination	10 (25%)

Project, the U.S. Department of Education, and the National Science Foundation's Statewide Systemic Initiatives (SSIs). (In fact, a number of the SSIs have made use of Project 2061 materials, especially *Benchmarks*, in their reform efforts; see "Impacts on Other State Policies and Practices," below, for specific examples.)

As noted above, NSTA's *The Content Core: Scope, Sequence, and Coordination (SS&C)* is used by the leaders much less often than the *National Science Education Standards* or documents from Project 2061; also, more than 60% of them do not believe that *SS&C* has been or will be used in their respective states. In part, this finding reflects the fact that the document was designed to serve a different, more prescriptive purpose: to chart a particular, innovative format for the science curriculum. Many leaders, however, also suggested that *The Content Core* was either past its prime or too traditional. Although they noted that *SS&C* was used at one time, most thought it was the least popular of the well-known science reform documents among educators in their state. Many of the leaders found *SS&C* to be more demanding with respect to content, getting away from the "less is more" strategy promoted in more recent documents. Some leaders commented that the document was appropriate mainly for middle and high school teachers, and therefore not as effective as a document to guide overall reform strategy.

Uses of Project 2061 Documents

Regarding the specific influences of Project 2061, nearly all said Project 2061 had played a major role in defining science literacy in their respective states. Nearly half spontaneously mentioned Project 2061's emphasis on the integration of mathematics and technology into science when asked specifically how Project 2061 had influenced their ideas about science literacy (see Table 4). More than a third of the leaders said that Project 2061 had moved the state in the direction of "less is more," i.e., emphasizing the inclusion of only the most important ideas within topic areas, rather than emphasizing the coverage of as many topics as possible. About a fourth said that the development of scientific habits of mind or cross-cutting themes were emphasized. Only 15% spontaneously mentioned that Project 2061 emphasizes the inclusion of major episodes in the history of science.

Table 4

Project 2061 Influences on the Definition of Science Literacy (n = 39)

Connections of science to mathematics and technology (integration)	18 (46%)
Inclusion of only the most important ideas within topic area ("less is more")	14 (36%)
Emphasis on cross-cutting themes	10 (26%)
Development of scientific habits of mind	10 (26%)
Inclusion of major episodes in science history	6 (15%)

Many leaders also mentioned that Project 2061 is consistent with the notion of inquiry-based, constructivist teaching that is more "hands-on" than traditional teaching. Others said that the Project 2061 materials do a good job of introducing a "scientific way of thinking" to elementary teachers, who are often unprepared to teach science.

Many state leaders also believe that Project 2061 influenced the science education reform strategy in their states. When asked how, the leaders responded by either mentioning particular, influential aspects of Project 2061's strategy for science education reform or examples of state functions or activities in which Project 2061 is used (see Table 5). The most influential aspects of Project 2061's strategy were judged to be that the "benchmarks" were for all students, that there should be grade-specific goals predicated on research, that defining specific outcome goals is an important first reform step, that science is best learned through performing science, and that Project 2061 tools can aid local curriculum development. According to the leaders, the most common activity in which Project 2061 is used is to design curriculum standards or frameworks. Project 2061 documents were also used to develop curriculum materials and to plan sessions for teachers' professional development.

Table 5

Project 2061 Influences on Science Education Reform Strategy (n = 39)

Designing curriculum standards/frameworks	16 (41%)
For all students	15 (39%)
Grade-specific goals predicated on research	8 (21%)
Specific outcome goals as first step, other reform steps derived from outcome goals	6 (15%)
Developing curriculum materials	6 (15%)
Science best learned through performing science	5 (13%)
Tools to aid local curriculum development	5 (13%)
Topics chosen for inservice sessions/other professional development activities	5 (13%)

Impacts of Project 2061 on State Curriculum Frameworks

Within the states, one would expect that curriculum frameworks are an especially promising leverage point for Project 2061. The theory of systemic reform suggests that curriculum frameworks are supposed to guide state policies as well as teacher practice. According to the U.S. Department of Education, curriculum frameworks are a method for bridging the national standards to the classroom by "providing guidelines for the content of the curriculum and how that content should be organized and presented" (*Federal Register*, 57(146), July 29, 1992, p. 33602). Because governors, legislators, and other education leaders in many states have been interested in raising standards and using state policies as a tool for improving education, curriculum frameworks would be a reasonable place to look for evidence of change.

As potential sources of guidance, as well as consensus-building vehicles for educators and the public surrounding ambitious learning goals for all students, frameworks take on almost as many forms as the number of states producing them. These differences represent specific state histories and educational and political contexts.

Despite such variation, however, curriculum frameworks are expected to be an important channel to science education reform, and Project 2061's influence on them would therefore be significant.

Assessing the Appearance of Alignment in State Curriculum Frameworks

The first step in searching for evidence of Project 2061's influence on curriculum frameworks was to identify appropriate state-level documents. A wide net was cast in the sense that allowances had to be made for the variety of documents reflecting the breadth of state political and historical contexts. Forty-three states had appropriate curriculum frameworks, content standards, or some equivalent drafts or final documents. The other seven states were in the beginning stages of rewriting their state curriculum documents and did not have drafts available. The 43 documents were reviewed to find specific citations and references to Project 2061 and its documents, and to identify the contexts in which these references occurred.

One difficulty in tracing Project 2061's influences through curriculum frameworks or standards documents is that parroting national standards is not politically acceptable in most states. As an experienced science educator and framework writer argued, "States are very proprietary, want their own standards, want to have their name on it." Thus, curriculum frameworks that do not openly cite Project 2061 or its documents might nonetheless have been influenced by them.

A reading of the framework documents yielded three common categories of Project 2061 influence: bibliographic references, quotations pertaining to the vision of science literacy, and organizational structure.

Most commonly, *Science for All Americans*, *Benchmarks for Science Literacy*, or both are listed in the bibliography or reference sections of frameworks. In these instances, Project 2061 documents appear to be one of several key sources of information that include the *National Science Education Standards*, other leading states' documents, and, to a much lesser extent, *The Content Core: Scope, Sequence, and Coordination*. (See Exhibit 3 for an example of a state whose curriculum standards have been influenced

by Project 2061.) Specific concepts or standards may or may not correspond directly to Project 2061, but the references suggest that background knowledge of Project 2061 infused the writing process and contributed to the overall tone and purposes of the frameworks. Interviews with curriculum framework writers revealed that in cases where Project 2061 was a general reference, but not a source from which bodies of text or specific unique concepts were drawn, influence is difficult to articulate or to trace through the document itself. However, these writers believe that Project 2061 contributed to the complex process of determining the content to include. One writer explained, "We didn't use [Project 2061 documents] word for word, but you can see the influence. Students will value and use science based on observable evidence. [This was] synthesized from reading drafts from *Benchmarks* and *SFAA*." Another insider in one Eastern state said, "You won't see Project 2061 written on the pages, but the influence is definitely there."

In addition, many framework documents use excerpts from *Science for All Americans* to provide a definition of science literacy and the philosophy of science education. For example, Connecticut's *A Guide to Curriculum Development* draws from *SFAA* such statements as the following to illustrate philosophies that underpin and guide the goals and objectives of a science program: "Science is best taught as a procedure of inquiry. Just as reading is a fundamental instrument for exploring whatever may be written, so science is a fundamental instrument for exploring whatever may be tested by observation and experiment," and "Science is a body of facts, a collection of principles, and a set of machines for measurement; it is a structured and directed way of asking and answering questions" (Ch. 2, p. 8). Maryland's *High School Assessment for Science, Core Learning Goals* (p. 1); Ohio's *Model Competency-Based Program, Science* (p. 9); and the *Science Framework for Rhode Island* (p. 2-3) are all examples of documents that use direct quotations from Project 2061 to create a vision of science literacy and to provide the rationale for science education reform.

Exhibit 3

PROJECT 2061 IN COLORADO: INFLUENCE ON STATE SCIENCE STANDARDS

New legislation (in 1993) increased the state's role in education in this traditionally local-control state and called for state math and science content standards to be written in consideration of national documents. *Benchmarks* was conceptually useful in the development of the state science standards, completed in 1995, and was the first document writers turned to; however, its size, comprehensiveness, and scholarly basis limited its impact. The writers were concerned with crafting a politically acceptable document that was consistent with *Benchmarks* and the *NSES*, but did not feel compelled to accept the entire *Benchmarks* package. The standards will serve as the basis for "performance levels" at grades 4, 8, and 11, and a new statewide assessment (designed by a test development company) will in turn measure student achievement against these performance levels.

By law, districts must either adopt the state standards or develop their own standards that meet or exceed those of the state. The state provides no funding, however, for districts to develop their own standards, and unwilling districts need only tell the state they are in compliance. Higher-capacity districts (such as two SSI districts that were visited) do look at *Benchmarks* (and the *NSES*) as they create their own standards, but these documents are only one of many competing influences. Moreover, the state does not have an adequate support system to help teachers put these new ideas into practice, a fact that will, in the end, circumscribe the influence of the state documents (and *Benchmarks* and the *NSES*) at the classroom level.

A third major sign of Project 2061's influence on curriculum frameworks is the use of *SFAA* and *Benchmarks* as organizing tools. The degree of influence for this purpose varies from almost complete adoption of certain benchmarks—such as in the Rhode Island document, where a number of benchmarks have been reprinted with permission—to citing and relying on Project 2061 documents for specific concepts or ideas. For instance, Montana's *Tool Kit for Science Curriculum Development* credits Project 2061 for the categorization of process skills; the *Mathematics & Science Frameworks for Nebraska Schools* cites Project 2061 on particular concepts such as "Primary Forces and Motion" (p. F-3). In another example, *Benchmarks* helped determine the placement of concepts in the overall structure of the framework. One individual on the New Jersey standards-writing team commented, "The *Benchmarks* were

open in front of us at all times.... When we had trouble resolving controversy, like ways to word things or whether something was [grade] appropriate, we turned to *Benchmarks.*"

This reading of the available curriculum frameworks and other standards-type documents indicates that leaders in many states did turn to Project 2061 for guidance. The resulting documents include bibliographic references to *SFAA* and *Benchmarks*, quotations to help establish visions of science literacy, and organizational schemas similar to that of Project 2061. But, beneath the surface features, how closely was the substance of the documents aligned with Project 2061?

Assessing the Quality of State Curriculum Frameworks

To assess the quality of the framework documents requires substantial content knowledge, so evaluation staff convened an expert group of 20 distinguished science and mathematics educators to review 12 recently completed science and mathematics curriculum frameworks (of which 6 were in science). These frameworks (identified in Volume 2, Appendix C) were selected because they were recently produced under a federal math and science frameworks development program.[6] The expert reviewers were charged primarily with assessing the quality of the documents in terms of their fidelity to key national documents promoting science education standards, while taking into account the state context.

Overall, the reviewers found that the frameworks reflect the national standards documents, including *Benchmarks for Science Literacy*. However, framework documents rarely treat the full range of concepts found in *Benchmarks*, nor do they approach all concepts in the same manner as that publication.

Mirroring the findings of the staff review, the expert reviewers noted that all of the state curriculum frameworks they analyzed acknowledge the influence of the science education standards documents. Interestingly, the reviewers found that many of the

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[6] This approach also allowed the Project 2061 evaluation to leverage work being simultaneously conducted for the Eisenhower State Curriculum Frameworks Project and the Council of Chief State School Officers' 50-state framework study, supported, respectively, by the U.S. Department of Education and the National Science Foundation.

frameworks captured "the spirit and essence of the national standards and the *Benchmarks* remarkably well."

However, despite statements and charts in framework documents that claim alignment with national documents, the reviewers found some common gaps. One place where frameworks fall short of alignment with *Benchmarks* and the *NSES* is in omitting or subsuming major content categories, particularly in Science and Technology, Science in Personal and Social Perspectives, History and Nature of Science, and Health and Mathematics from *NSES*, and similar topics in *Benchmarks*. For example, the *Rhode Island Science Framework* mirrors closely the *Benchmarks* chapters on "The Nature of Technology," "The Physical Setting," "The Living Environment," and "The Human Organism," but completely omits "Human Society," "The Designed World," "Historical Perspectives," and "Common Themes."

In addition to omissions of major content areas, the reviewers found that some frameworks simplified the concepts found in the *Benchmarks*, while others diluted them. As an example, consider what two states' frameworks have to say on teaching about energy and force. *Benchmarks for Science Literacy* specifies that particular information and concepts about energy and force should be taught:

- Light from the sun is made up of a mixture of many different colors of light, even though to the eye the light looks almost white. Other things that give off or reflect light have a different mix of colors. (4F Motion, 6-8, #1)
- Something can be "seen" when light waves emitted or reflected by it enter the eye—just as something can be "heard" when sound waves from it enter the ear. (4F Motion, 6-8, #2)
- Energy can change from one form to another, although in the process some energy is always converted to heat. Some systems transform energy with less loss of heat than others. (8C Energy Sources and Use, 6-8, #1)
- Energy appears in different forms. Heat energy is in the disorderly motion of molecules; chemical energy is in the arrangement of atoms; mechanical energy is in moving bodies or in elastically distorted shapes; gravitational energy is in the separation of mutually attracting masses. (4E Energy Transformations, 6-8, #4)
- Every object exerts gravitational force on every other object. The force depends on how much mass the objects have and on how far apart they are. The force is

hard to detect unless at least one of the objects has a lot of mass. (4G Forces of Nature, 6-8, #1)

- Electric currents and magnets can exert a force on each other. (4G Forces of Nature, 6-8, #3)

In some states, the depth of the standard and the language used are very close to that of *Benchmarks for Science Literacy*. For example, the Nebraska framework lists these standards for middle school force and energy:

- Light from the sun is made up of many different colors of light. The electromagnetic spectrum has a wide range of wavelengths. Human eyes respond only to the wavelengths known as visible light.
- Forms of energy include heat, chemical, mechanical, and electrical energy. Any form of energy may be transformed into any other form of energy.
- Gravitational and electromagnetic force should be emphasized. Every object exerts gravitational force on other objects. The amount of force is dependent on the mass of the objects and the distance between them.
- Electric current involves the motion of electrons. Electric currents and magnets exert force on each other.

In this case, some portions appear almost identical to *Benchmarks* in sophistication, such as: "Light from the sun is made up of many different colors of light." "Every object exerts gravitational force on other objects. The amount of force is dependent on the mass of the objects and the distance between them." "Electric currents and magnets exert force on each other." However, it is also clear that *Benchmarks* demands more depth in other sections, for example, that heat is produced in all energy transformations, and more specific information about various forms of energy.

In another state science framework, the fundamental concepts are diluted:

- Identifying the characteristics of and understanding relationships among heat, light, sound, magnetism, and electricity.
- Understanding the different kinds of energy transformations and the fact that energy can be neither destroyed nor created.
- Comparing the types of energy and the processes involved in the absorption and scattering of light.

- Describing the types of energy that can be involved, converted, or released in electrical circuits.

The reviewers argued that in this example, the standards had become so diluted by generalization that they doubted "a teacher or other practitioner could make use of them and certainly could not develop assessment tasks to measure the stated standard."

In addition to fidelity to national content standards, another criterion the experts considered in evaluating framework quality was that of equity: the opportunity for all students to achieve high standards. This is one of the principles underpinning standards-based reform and Project 2061's vision of science literacy. In considering meaningful ways of addressing equity issues, the experts found that every framework under review mentioned these issues. However, they were critical of the treatment of equity in all frameworks, even those with the strongest equity components. Frameworks generally lack concrete examples and vignettes designed to deal with the "implementation of equity-sensitive teaching in the classroom." The reviewers mitigated this general criticism somewhat by acknowledging that national documents lack models of classroom vignettes that give advice and guidance to the states on how to seriously address equity concerns, despite the fact that achieving science literacy for all students is stated as a primary goal in national documents.

Contexts for Project 2061 Influence on State Curriculum Frameworks

Consistent with the data reported in previous sections, state and local leaders interviewed for the case studies stated that the greatest influence of Project 2061 documents in their states has been on the development of state and district curriculum frameworks. Among the six case study states, four made direct use of Project 2061 documents in putting together their state frameworks or standards. *Benchmarks* was the most significant document consulted in Colorado. Of the four, only South Carolina decided to align its state framework more closely with *NSES* than with *Benchmarks*. Currently, New Jersey, Georgia, and Wyoming do not have state frameworks—although Project 2061 was the most significant document consulted in the writing of New Jersey standards (see Exhibit 4) and did significantly influence the development of Georgia's

"Learning Framework" (which, however, has not been endorsed by the state superintendent). Wyoming's leaders in science education share much of Project 2061's vision.

The development of both state and district frameworks is usually heavily influenced by contextual factors, but two noteworthy trends related to Project 2061 can be seen in the case studies. First, the timing of *Benchmarks* appears to have been ideal for states that put together frameworks during the past few years, since the final version of *NSES* was published only in December 1995. Second, in some states, such as Colorado, the transmission of Project 2061's ideas from the state to the district level has been very successful—a finding that serves in a sense to verify the idea that state frameworks can serve as an important influence throughout a state. (Of course, influencing a district framework, test, or curriculum is still not enough—changing teaching and learning in classrooms is the ultimate goal—but it is an important start.) The fact that Colorado requires districts to either adopt the state standards or meet or exceed them with their own set of standards has led some districts to study closely not only the state framework but also *Benchmarks* and/or *NSES*. New Jersey's science curriculum framework is likely to be heavily influenced by *Benchmarks* (as were the science standards), and it is anticipated that the framework, in conjunction with statewide assessment, will drive content, professional development, and assessment at the district level. Also, New Jersey's SSI continues to use *Benchmarks* directly in its professional development activities.

On the basis of evidence from the case studies, the staff review, and the panel review, there is no question that, at this point in time, the greatest impact of Project 2061 in the states has been on state curriculum frameworks. The next section presents evidence about Project 2061's impacts on other aspects of education.

Exhibit 4

PROJECT 2061 IN NEW JERSEY: LINKS TO STANDARDS, THE SSI, AND TEACHER PROFESSIONAL DEVELOPMENT

New Jersey's State Board of Education approved new standards in seven content areas in May 1996. Project 2061 documents were described as influential with the science standards committee, which used *Benchmarks* extensively. The state department hopes to complete a science curriculum framework within one year, while simultaneously piloting a new 4th-grade assessment and adding science to the existing grades 8 and 11 assessments. The intention is to align all these assessments to the standards.

The state's SSI has focused primarily on professional development programs, and has recently built partnership clusters of school, district, and professional development institutions. The state department of education may use this "cluster model" as the starting point for a systemic effort to build teacher capacity in support of the new standards. SSI partner institutions also use *Benchmarks* in their professional development programs.

With a strong tradition of local control and no state textbook adoption policy, the extent of influence at the district level is less clear. The ways in which *Benchmarks* is viewed and used at the district level vary tremendously. In some instances, it was evident that *Benchmarks* is but one of many resources the district science supervisor uses and shares with teachers. In other districts, the influence of *Benchmarks* is stronger, and the district supervisor draws directly from the document to write the district curriculum, uses it for inservice topics, and cites it to lend credence to arguments for reform. Some professional development providers and district science supervisors in the state have requested an analytical tool that would apply *Benchmarks* in creating a district curriculum.

Impacts on Other State Policies and Practices

In addition to establishing or revising curriculum frameworks, there are a great many "policy levers" that states can use to influence, regulate, or control their systems of education. States can set high school graduation requirements, requirements for entry into state colleges and universities, and teacher certification and recertification policies. States often fund a variety of institutions to provide inservice teacher professional development, and they establish formulas for distributing education funds. These are just a few policies that might be subject to revision as part of the effort to reform science and

mathematics education, and many other policies are established at other levels of the education system, including the district and school levels.

A discussion of each of these components of reform, and how Project 2061 is influencing them, is beyond the scope of this evaluation. Although the qualitative research conducted for the case studies shows that there are a variety of important channels of influence, including textbook adoption procedures, the SSIs, and others, it must be recognized that Project 2061, like every effort to fundamentally rethink education practice, faces political and technical hurdles that can be expected to slow the pace of change. Several of these barriers are also discussed below.

The Impact of Politics

In almost every state (including five out of the six case study states), unexpected political events have influenced or altered education reform plans. The growth of state-level reform efforts and national debates about systemic reform have increasingly drawn educators and the schools into the political arena, while politicians have become more active in educational policy-making (Boyd and Wohlstetter, 1996). Among the case study states, the most frequent political debate surrounded the controversial topic of curriculum frameworks. In Georgia, a new Learning Framework created by the state SSI has created vigorous discussion and political maneuvering. Also, such hot-button topics in science as evolution and sexual reproduction grabbed headlines in a few of the case study states.

Attempts at standards-based reform may find themselves at odds with the political climate of the day: the return of power to states and localities. In Georgia, Colorado, and South Carolina, both state- and district-level officials spoke about some of the public's unfriendliness toward any "national" reform effort.

In many states, political changes resulted in deep cuts in state departments of education and a loss of capacity and content expertise. For example, the New York State Department of Education was forced to cut about 40 percent of its staff. Although these cuts resulted in a serious loss of capacity in the state department, including a reduction in

expertise about science and mathematics education, the political changes were not so dramatic as to stop the reforms under way. Indeed, some initiatives of the new commissioner appear to have reinvigorated the science education reform effort.

Another legislative matter that appears relevant from examining the six case study states is whether or not frameworks are voluntary at the local level or are required under law. Only Colorado requires districts either to adopt the state's standards or create their own frameworks that meet or exceed the state standards. (South Carolina also imposes some requirements.) If not required by law (or tied to assessments or to other sanctions or rewards), some districts will pay lip service to frameworks and hope that they soon disappear.

Assessment of Student Learning

Politics can also play an important role in a state's assessment system, a fact that has the potential to seriously limit reform efforts. Whereas assessment of students is a principal component of a few states' standards-based reform plans (plans are in the works in Colorado, New Jersey, and South Carolina), misalignment of the assessment system has seriously impeded reform efforts in both Georgia and New York (see Exhibit 5). The reform of a state's assessment system is a long, difficult, expensive, and often politically charged process. (California is often offered as a prime example.) There can be a troubling lag time of several years or more between the development of curriculum frameworks and subsequent changes in the way a state measures its students' performance. Although the aforementioned states have plans to alter or add new assessments, new systems have not been implemented yet, and in South Carolina the lack of a new assessment system (currently under development) has created a somewhat "schizophrenic" reform scene.

The state assessments in both Georgia and New York, which are not aligned with reform efforts or new curriculum frameworks, are given a lot of weight and taken quite seriously by educators and the public. For example, in Georgia teachers feel they must spend a lot of time preparing students for fact-filled, "basic skills" tests. Professional

development based on such tests gives teachers a less than subtle message about what they should be teaching their students, and newspaper reports of schools' scores also put pressure on teachers to teach to the test. On the other hand, the reform of an assessment system can be a positive force driving education reform.

Exhibit 5

PROJECT 2061 IN NEW YORK: THE ISSUE OF ASSESSMENT

State officials in New York credit Project 2061 with direct influence on their thinking and on their new mathematics, science, and technology framework. Dr. James Rutherford, the director of Project 2061, chaired the state's frameworks committee. The prominence of technology in the new framework is, in part, a result of Project 2061's influence.

It is less clear how direct and how strong Project 2061's influence has been on the local districts in the state. Most New York districts develop local frameworks, or scope-and-sequence documents, that lay out the specific curricular goals for the district. District officials and teachers interviewed for the evaluation argued that the district documents are the ones most likely to shape the local curriculum. How well these local documents reflect Project 2061's principles, or the state framework, is still an open question.

At the high school level, New York's new Commissioner of Education is interested in expanding the influence of the State Regents' examinations, by having all students sit for the exams, not just those who are college bound. The new framework is intended to guide the development of assessments, but to what extent the Regents' exams in science will reflect the principles of Project 2061 is as yet unknown. At the elementary level, Project 2061 has influenced the state's current science assessment, but only certain Project 2061 principles are reflected in the test.

The problems with assessment in some of the case study states are not isolated examples. A recent review of student assessment systems across 25 states shows that, overall, they are poorly aligned with either national reform goals or the SSIs in those states (Laguarda, Breckenridge, and Hightower, 1994). It was reported that only 16 of the 25 SSI states have *any* statewide assessment in science, and few among them are aligned with *Benchmarks* or the science standards. The fact that, especially at the elementary level, science is not yet considered a "basic" partially explains why required testing is so

much rarer in science than in reading or mathematics. This situation is changing slowly, at best.

Among the case studies, Wyoming is an example of a state with no state-required testing. According to theories of standards-based reform, this lack of state testing may make it more difficult in Wyoming to monitor student learning and to hold schools and teachers accountable for results. New legislation may change this situation.

Teacher Professional Development

One of the reasons that curriculum frameworks are not a simple bridge from national standards to the classroom is that teachers typically require a lot of time to become familiar and comfortable with the concepts embodied in the national standards. Yet states vary greatly in the amount and the nature of teacher professional development offered to and engaged in by typical teachers in the state (Knapp, Zucker, et al., 1991). Without high-quality professional development, national standards and state curriculum frameworks may appear to teachers to be little more than attractive, but highly abstract, philosophies.

On the positive side, the case studies show that SSIs are generally well aligned with Project 2061. This means that professional development funded by the SSIs is typically in support of the national standards and Project 2061. This is true in Colorado, Georgia, New Jersey, and New York, among the six case study states. (In South Carolina, the SSI strategy is complex, and the SSI does not often provide services directly to the teachers.)

However, the case studies also include instances where the lack of professional development aligned with science standards creates a significant problem. In Colorado, for example, despite the state's new legislation creating a standards-based education system, an effective infrastructure is simply not in place to educate the tens of thousands of teachers in the state who need training. Perhaps the new legislation will result in improvements in teacher professional development.

Positive Connections with the SSIs

As previously noted, Project 2061 has particularly positive ties with the NSF Statewide Systemic Initiatives, making that program an important channel of influence for moving ideas from national documents to the states. Five of the six case study states have current SSI projects funded by NSF to help improve math and science education, and many of the SSIs make use of or promote Project 2061 documents. For example, New Jersey's SSI uses *Benchmarks* in its professional development programs. In Georgia, where the state has only the Quality Core Curriculum created in the mid-1980s and where there has been resistance to standards-based reform, the SSI developed its own "Georgia Framework for Learning Mathematics and Science," based primarily on *Benchmarks*. In Colorado, New York, and South Carolina, the SSI projects are helping to move districts (and in South Carolina the state department) toward national science education reform goals, and are creating implementation models for systemic reform.

Influencing Textbook Adoption

Textbook adoption appears to be an area in which Project 2061 may wield a lot of influence. Two of the 6 case study states are textbook adoption states (as are about 20 other states). In one of them, Georgia, Project 2061 was clearly influencing the science textbook adoption process (see Exhibit 6). (South Carolina had an analogous situation with elementary mathematics textbooks, but not yet in science.)

All three districts in Georgia that were part of the case study were using Project 2061 as they selected science textbooks, and one was in the process of rating potential texts specifically on how well they aligned with *Benchmarks*. As noted in Chapter II, textbooks still drive the majority of curriculum in classrooms today, so even a modest impact on this process can result in changes in the curriculum for many students. Project 2061's documents are useful to teachers on textbook committees as they think about what should be included in a textbook and how it should be organized. A document like *Benchmarks*, with its focus on appropriate curriculum at four grade ranges, is also especially relevant in choosing elementary textbooks.

Exhibit 6

PROJECT 2061 IN GEORGIA: IMPACTS ON TEXTBOOK ADOPTION AND A NEW LEARNING FRAMEWORK

Georgia is a textbook adoption state and has a Quality Core Curriculum (QCC) in a number of different content areas that districts use as guides for their district curriculum. The 7-year adoption cycle focuses on science this year, and, indeed Project 2061's most significant impact at the local level has been on textbook adoption—all three of the districts visited had been significantly influenced by Project 2061 in their adoption process.

Although Georgia has not traditionally been described as a strong local-control state, the local districts and schools have considerable control over education provided in their schools. The state has been resistant to standards-based framework development, although the QCC is scheduled to be revised this summer. Despite much public support from teachers, teacher associations, and the State Board of Education, it is unclear what role, if any, the SSI's recently developed and somewhat controversial "Georgia Framework for Learning Mathematics and Science" will play in the QCC revision. Project 2061's most significant impacts at the state level have been on key players and thinking about the science framework. On the other hand, Project 2061 (and the SSI) has had little impact on state-level assessment, which has a powerful influence in districts.

Teachers have been influenced by their involvement either with the Project 2061 Center or with the SSI, but on a statewide basis, this probably represents a small minority of all teachers. If Project 2061's influence has been greatest on the SSI framework, that may also represent the limits of its influence, since some district administrators are hesitant to endorse or use the SSI's "Learning Framework" until something definitive occurs at the state level.

Competition among Documents

Even as the states attempt to better align professional development, student assessment, teacher certification, and many other components of the education system with one another and with higher standards, there will be competition for attention between various documents. The state curriculum frameworks, with the strengths and weaknesses described above, will serve as one source of information for aligning other components. Alternatively, states, districts, and even teachers may turn to the *National Science Education Standards*, *Benchmarks for Science Literacy*, the New Standards Project, recently published standards for professional development (National Staff

Development Council, 1995), or other documents. South Carolina provides an example of a state in which the *National Science Education Standards* has proved the most influential document (see Exhibit 7).

As long as the messages in these documents are largely the same, it may not matter which one is used (although great fidelity to *any* single source would also be less likely). Nonetheless, the potential for confusion has increased, particularly now that the *National Science Education Standards* have been officially released. How clearly do readers distinguish between these documents?

Perceptions of Project 2061 and the *National Science Education Standards*

This section summarizes findings about different groups' perceptions of the similarities and differences between *Benchmarks for Science Literacy* and the *National Science Education Standards*, as well as their impressions of how the documents will be used. These findings may be useful to inform deliberations about how the documents can best be used together, including Project 2061's efforts to collaborate with the National Research Council.

State Leaders' Perceptions of Similarities and Differences

Almost all interviewees, including 81% of those with whom we conducted the structured telephone survey, believe that there are no or only minor differences when asked whether they "see any important differences between the *NSES* and *Benchmarks* in terms of their respective visions for science education reform and definitions of science literacy." "They have the same vision, but different approaches" was a frequent comment. There was some significant variation by audience, with the data showing that 88% of curriculum framework writers believe there is no difference between the documents, compared with 79% of state science supervisors and 58% of professional association leaders.

Exhibit 7

PROJECT 2061 IN SOUTH CAROLINA: MINIMAL DIRECT INFLUENCE

The state is the locus of control for education in South Carolina, and assessments have been the driving force. The state's education vision is that high academic standards, adequate resources, local control, and accountability will lead to success for all South Carolina students. The state is attempting to move away from a "basic skills" approach, and has recently released new or draft frameworks in eight subject areas. New assessments are being created based on achievement standards derived from the math and science frameworks. The state science framework (approval expected in fall 1996) is closely aligned with *NSES*, and Project 2061 materials were used only as a reference. South Carolina has statewide textbook adoption, and the recently adopted elementary mathematics texts are said to be in alignment with the new mathematics framework. The state's strong SSI is working closely with the State Department of Education to move science and math reforms forward.

Districts have begun creating new districtwide curricula based on the state frameworks. Some district personnel, teachers, and administrators said they "knew of" the national documents, but they referred primarily to the state frameworks. Bold accountability legislation was tabled this year, and the result is that education in the state is somewhat "schizophrenic" at the moment: districts and teachers are expected to work from the new frameworks, but incentive pay, as well as other rewards and sanctions for their work, is still being driven by the old basic skills assessments. The education funding system has led to great disparities in funding among districts and is currently under review. Because of these disparities, and in part because of the infancy of the reforms, significant reforms in science and math tend to be found only in pockets throughout the state.

In general, state science supervisors possess the most cogent and accurate perceptions of the relative strengths of the documents. They believe that the content standards greatly overlap and, where they do not, that they enhance each other in important ways. *Benchmarks for Science Literacy*, many believe, has a "broader definition of science literacy, including social science and mathematics, and the history of science," in the words of one respondent.

Most of the state science supervisors who were interviewed think that *Benchmarks* is better able to communicate the notions of science literacy to teachers. "*Benchmarks* is more teacher friendly [than the *NSES*].... It describes the concepts more, and the grade

clusters are more age-appropriate," according to one state science supervisor. On the other hand, state science supervisors consider the *NSES* more "inclusive" because it includes the teaching, professional development, assessment, program, and system standards, providing a "total concept of what things should be like.... You need all those components."[7] They believe that the state and district administrative levels will refer to the *NSES* for standards regarding these other components of systemic reform. Thus, state science supervisors feel that the two documents possess complementary strengths suited to different purposes and use both documents. (See Exhibit 8.)

Audiences other than state science supervisors have a less comprehensive understanding of *Benchmarks* and the *National Science Education Standards*, seeming to draw out aspects most salient to their work and compatible with their views on science education. For example, to any given user, *Benchmarks* does not simultaneously represent or convey interdisciplinary connections to math, social studies, and technology, major episodes of science history, habits of mind, "less is more," science for *all* students, research-based grade-level-specific goals, inquiry-based hands-on instruction, and so on, although these are all fundamental principles underpinning Project 2061's vision for science literacy. This variation in perceptions of what *Benchmarks* and the *NSES* represent will lead to variation in beliefs about impacts the documents will have at the local level.

Beliefs about Local Uses of the National Documents

The major concern surrounding all of the national documents is their implementation at the district, school, and classroom levels. State teacher association leaders and the teachers themselves are most concerned about the usability of the documents by rank-and-file teachers. The benefits that teachers might gain from exposure to the national

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[7] Project 2061 is also concerned with changing other components of the education system, besides curriculum and instruction. For example, the Project is creating *Blueprints for Reform* (a working title), which will be published by Oxford University Press. There are about a dozen chapters, each focusing on a different component, such as preservice teacher preparation and technology, media, and materials.

Exhibit 8

PERCEPTIONS OF THE DIFFERENCES BETWEEN *BENCHMARKS FOR SCIENCE LITERACY* AND THE *NATIONAL SCIENCE EDUCATION STANDARDS*

***Benchmarks* Strengths**	***NSES* Strengths**
"[*Benchmarks*] is not a bible..., but it's a good place to start when thinking about what is relevant in teaching a particular unit." - *Teacher educator* "2061 has more in-depth coverage or treatment of content. Great for teachers. They're the ones who have to implement. They want to know how to do this stuff in the classroom. Across the board, the content is better than *NSES*.... I look at the *NSES* as the umbrella and 2061 as all the ribs under the umbrella." - *State science supervisor* "A teacher needs to be able to get a sense of a document fairly quickly for it to be teacher friendly. *NSES* is not like that, but *Benchmarks* is." - *State teacher association leader*	"There is not a big difference between the two documents in terms of vision...more in terms of emphasis. The *Standards* seem to...more clearly define...what kids are going to be doing and knowing. The *Benchmarks* are more general or flowery." - *State teacher association leader* "I think the *National Science Education Standards* are better and provide a more balanced view, but teachers want to know what to teach, so they look to *Benchmarks*." - *SSI principal investigator* "The *Standards* give you a vision of what it would look like, what it would look like in a classroom with the vignettes, the assessment pieces, and the community standards and other stuff that *Benchmarks* lacks." - *State teacher association leader*
***Benchmarks* Weaknesses**	***NSES* Weaknesses**
"*Benchmarks* does not meaningfully address professional development, teaching and learning of students, assessment of the teaching and learning of students or teachers—areas that are critical for the movement of science education reform." - *Curriculum developer* "I don't think *Benchmarks* addressed continuity across systems, e.g., across districts, administration, instructors, supervisors, business." - *State science supervisor*	"*NSES* is quite traditional in content (but *Benchmarks* is different because it integrates mathematics and technology on an almost equal footing to science)." - *State science supervisor* "*NSES* does not have social science and math." - *State science supervisor*

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documents may be mitigated by the confusion of adding these thick documents to the others that teachers are supposed to use, including the state curriculum framework, state standards or state tests (if they exist), and the district framework.

According to one district science supervisor, "I don't encourage teachers to use *Benchmarks* or *NSES* because I don't want them to be more confused.... The district spent a great deal of time and effort to create a district framework that incorporates the aspects of *NSES* and *Benchmarks* that we agree with. Teachers should use the district document first." A prominent teacher educator believes that teachers "are not sure what [*NSES* and *Benchmarks*] are, why they should pay attention to them, or what to do with them. Teachers are not familiar with all of the documents or how they fit together."

It is unlikely that there is, as yet, widespread awareness of the documents among teachers, and therefore teachers' future use of the documents is somewhat uncertain. Evidence from other sources suggests that the state- and district-level administrators' skepticism about the incidence of any national documents has some basis. In Horizon Research's 1993 National Survey of Science and Mathematics, 62% to 79% of science teachers (depending on grade level taught) rated district curriculum frameworks or courses of study as a "major" or "significant" influence on what they teach. At the same time, only 18% of grades 1-4, 28% of grades 5-8, and 56% of grades 9-12 teachers were "well aware" of the NCTM standards, even though they had been published in 1989.[8]

Accordingly, many state and district staff expect the district- and state-level frameworks to have the most impact. One state science supervisor "hopes the [state] content standards will be referred to first within the state." Another state science supervisor argues that "99% of teachers will go to [state standards], and that's what they will be required to do. Teachers don't have time to do that kind of research [with outside

[8] A 1995 survey of teachers conducted by the National Science Teachers Association produced more positive results, such as the finding that 80% of the respondents agreed that the *National Science Education Standards* would improve the way that science is taught in their classrooms. However, many teachers did agree that there were significant barriers to implementing the standards. The survey's low response rate, less than 40%, raises questions about the accuracy of the findings (*Education Week*, April 10, 1996).

documents] and shouldn't have to." In another state, "credibility with the state model is tremendous, and Washington, DC, [i.e., national documents] doesn't have the same credibility."

By contrast, in a few locales, administrators believe that the state and district documents will not provide the kind of detail that teachers will need and they will therefore look to *Benchmarks* or the *NSES* as a resource. "[Our state] doesn't have the latitude to get very specific.... The document is on big ideas, one document for all audiences.... Every school and teacher will have to do their own task analysis, and then they will go to *Benchmarks* and *NSES* to infill.... What to teach will have to come from *Benchmarks* and *NSES*."

State science supervisors do anticipate that supervisors at the district level will find the content and professional development standards in the national documents particularly useful. "Principals and district administrators will use the *NSES* to see what they can do," says one state science supervisor, "for example, [changing] how time is allotted, providing teacher planning time.... *NSES* gives them tools they can leverage, gives attention to things not done before."

In light of the case studies, what seems clear is that actual use at the district level is contingent on the state context. For example, in states that are very oriented to "grassroots" policy-making in education, state science supervisors find it unlikely that their districts will turn to national documents. One source close to a Western state education department believes that national standards are a "political liability, especially in states like [ours] that will use *Benchmarks* as a template but need to make their own standards." Yet the case study in Wyoming does show that the *ideas* in the national documents are broadly acceptable to educators even in strong local-control states, whether or not they are directly used at the local level or referenced in official state documents. By contrast, Colorado also has a strong tradition of local control; however, state legislation requires that districts meet or exceed the state standards. The Colorado districts, in that context, may refer directly to the national documents for assistance in defining a curriculum that will meet or exceed the state standards. One Colorado district

science supervisor interviewed for the case study uses the national documents, which "influenced the grade at which the district began offering science by discipline."

The Future Influence of Science Education Standards

Approximately half the interviewees believe that the *NSES* will have more impact on science education than NCTM has had on mathematics education—mostly because the NRC was able to begin with the consensus built when Project 2061 brought the science community together to define what students should know. Sixty-two percent of state science supervisors believe that the potential impact of the science standards is as great as that of the NCTM standards.

However, the more common argument from state NSTA leaders and national reformers is that the science disciplines in the field will prove too fragmented to coalesce around the single set of standards necessary to effect the long-term impact that Project 2061 and the NRC seek. Some people are also concerned that the perceived competition between national documents will weaken the coalition for a single set of science education goals and standards. The result is that only 30% of the professional association leaders interviewed believe that the *National Science Education Standards* will have as great an impact as the NCTM standards have had.

Is the glass half full or half empty? (See Exhibit 9.) In light of the strong standards-based reform movement at the federal level and in most states, an appraisal of concerns about local implementation may best be viewed as a realistic assessment of the difficulty of effecting reform, not as a criticism of attempts to set standards in the first place.

Conclusion: Project 2061 in the States

There are 50 states, nearly 15,000 school districts, and about 100,000 schools in the United States. At this point, what can be said about the aggregate impact of Project 2061 in the states?

Exhibit 9

PERCEPTIONS OF THE FUTURE IMPACT OF NATIONAL STANDARDS FOR SCIENCE EDUCATION

Reasons for Optimism	Reasons for Skepticism
"I think it [will have] more [impact than NCTM]. *NSES* is the first comprehensive document that adds all the components of the system together.... There was more widespread collaboration in development and publication of *NSES* [than in NCTM]." - *State science supervisor*	"[The documents] are not realistic and they have not influenced me.... When we plan workshops, we give the teachers what they want, and so far teachers are not requesting we go over these documents." - *State teacher association leader*
"States are lining up to match [their frameworks] to *NSES*. [After seeing the *NSES*] some states are redoing their frameworks to include assessments, which is what happened when the NCTM [standards] came out." - *State science supervisor*	"*NSES* will not have the same impact as NCTM. Too much diversity in science education, too many audiences, too many people do not believe that science literacy is a worthwhile goal." - *State science supervisor*
"The amount of buy-in, the time [they took] to develop, the sign-off from many groups of people means there is already a base of influence." - *State science supervisor*	"It is difficult to think of the nation as a whole having teachers with the skills and knowledge necessary to implement the Standards. Teacher preparation is a big void. At most, the Standards may be widely adopted on a superficial level." - *State teacher association leader*
"I hope both *Benchmarks* and *NSES* have a much more dramatic impact [than NCTM]. If they do nothing more but increase the inquiry component by 10%, they will have positively impacted science education in a significant way." - *State science supervisor*	"Many science teachers probably do not know [the *NSES*] exist. Many teachers, unfortunately, have other concerns besides teaching science, like discipline and large classes. The *NSES* will be a low priority for these teachers." - *State teacher association leader*
	"Math is up there with reading in importance; science is not [to the public].... Until science is seen as just as important, textbook publishers and others won't get on the bandwagon." - *State teacher association leader*

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Clearly, Project 2061 has been very successful in influencing curriculum frameworks. If their role in reform is as strong as theory suggests, this is an especially promising finding. (After all, the theory of systemic reform depicts curriculum frameworks as the guide for other state policies that influence classroom practices more directly, such as student assessment and teacher professional development.) However, there is reason for caution here.

The evidence suggests that few states actually approach reform in this linear way. Most often, curriculum frameworks are one among many different reform activities under way at the same time. Curriculum frameworks can guide other education policies, they can reflect the reform efforts, or they can detract from other, more promising initiatives. Evidence from the states SRI has been studying suggests that curriculum frameworks are as likely to be reflectors as beacons. In addition, state curricular guidance, in the form of curriculum frameworks, is vulnerable to political changes in the states and to the deep skepticism of teachers (for example, see Chapter IV, concerning Project 2061's workshops).

It also appears that it is generally higher-capacity, typically wealthier districts that are more likely to make serious attempts at standards-based reform. Regardless of what state frameworks may say, smaller, poorer, and urban districts (in New York and Colorado, for example) may not have the capacity or interest to participate and are therefore less likely to be influenced by Project 2061. "Other factors" in these districts are often just as important as considerations of the science curriculum, if not more so, and may dominate the reform agenda of local leaders. (For example, in South Carolina an inequitable system of funding that has led to great disparities among districts is currently under review.) Thus, Project 2061's clear message that science literacy is important to *all* students is being tempered by a host of political and fiscal realities that make it harder to achieve this goal in some places than in others.

Project 2061's success in influencing curriculum frameworks is still an important achievement, in that the frameworks are usually an expression of what a state's leading

educators believe. This caution is simply to acknowledge that, thus far, curriculum frameworks do not appear to be an easy bridge from the national standards to the classroom. Instead, they appear to be only one potential avenue of influence on education policy and teacher practice.

IV. PROJECT 2061 WORKSHOPS

The preceding chapters have explored the impacts of Project 2061's two major publications at the national level and in the states. There have been significant impacts at both levels, although the evidence shows that some important components of the education system have been deeply affected while others have not. A complementary strategy for Project 2061, besides issuing publications, has been to conduct workshops about those publications. Each workshop typically is targeted for one specific type of audience (e.g., classroom teachers). This chapter summarizes efforts to answer the third research question, which asks: "What are the impacts of Project 2061 workshops on several groups of participants: teachers, teacher leaders, and teacher educators?"

The methodology section of the chapter explains the choice of those particular three audiences, the sampling strategy, and response rates. Next, for each audience, relevant demographic statistics are presented to indicate the nature of the group, as well as the main reasons cited for attending the workshop, the primary benefits derived, perceptions of the main ideas conveyed, changes in professional practices, and any suggestions for improving the workshops. Finally, participants' reflections on the effectiveness of the Project 2061 workshops are summarized.

Methodology

Audience

From workshop activity since September 1994, three separate participant groups were identified and surveyed to determine the effects of Project 2061 workshops on their practices. Although a common set of questions cut across the survey instruments for each of these groups, segmenting the participants allowed questions to be asked within the context of their roles in science education and reform. The research interest was primarily in workshops of a half-day or longer, where the intention was to provide the participants some exposure to and skills in using Project 2061 tools. Project 2061 staff conducted many such workshops at NSTA conferences, where teachers clearly constitute a primary audience. Teacher leaders (members of the Project 2061 Leaders Network)

also represent a significant Project 2061 investment and effort, including an annual 3-day summer workshop. Teacher educators are a third large, identifiable audience for whom at least three multi-day workshops were held. As it turns out, the reported impacts on the three audiences are not the same.

Sampling

Ideally, a representative sample of workshop participants would have been drawn from a complete list (universe) of known participants. However, because of limited information on participants, only those for whom name and address information could be found were included in the survey. Such information was most limited on the teacher participants because participant lists were not collected systematically at the teacher workshops. Project 2061 staff were able to gather data sufficient to survey 143 participating teachers.

Virtually complete data existed for the teacher leaders who have attended workshops to date, and all 69 participants were sent surveys. Almost complete information also existed on teacher educators who attended three separate workshops on preservice science teacher education; 97 participants were sent surveys. All participant lists were checked for redundancy.

Response Rates

Several tactics maximized response rates. After an initial mailout to all participants, a reminder card was sent to all nonrespondents, timed to correspond with the original deadline stated in the cover letter. Two weeks later, all remaining nonrespondents received telephone calls encouraging their participation. Three weeks after that, a new copy of the survey was sent to the remaining participants who had not yet responded. The final response rates were 64%, 62%, and 57%, respectively, for teacher, teacher leader, and teacher educator surveys.

Results of the Teacher and Teacher Leader Surveys

This section will report results of the teacher and teacher leader surveys. "Leaders" will refer to members of the Leaders Network, to whom the teacher leader survey was directed, and "teachers" to all other teacher respondents, to whom the teacher survey was administered. The teachers and leaders are grouped together because both groups are predominantly K-12 practitioners. Results of additional questions for the leaders follow this section.

Who Attended the Workshops?

An examination of the teacher and leader participants' backgrounds demonstrates that, along a number of different dimensions, participants are above-average science teachers. A substantially higher percentage of teacher respondents and, to a lesser extent, leaders hold science and science education degrees than the national average reported in the 1993 National Survey of Science and Mathematics Education (Horizon Research, 1995). Table 6 compares the respondents' levels of education with that of the national sample.

Table 6

Percentage of Respondents with Undergraduate or Graduate Degrees in Science or Science Education

	Evaluation of Project 2061		1993 National Survey of Science and Mathematics Education		
	All Grade Levels		Grade Level		
Degree Major	**Teacher**	**Leader**	**1-4**	**5-8**	**9-12**
Science	80	54	3	18	58
Science education	38	27	0	2	6
Joint science and science education	4	2	0	1	9

The survey respondents also report participating in more professional development than what was found in the national study (Table 7).

Table 7

Percentage of Respondents at Each Grade Level Attending More than 35 Hours of Inservice, by Audience

	In Past 12 Months			In Past 3 Years		
	Grade Level			Grade Level		
Audience	**1-4**	**5-8**	**9-12**	**1-4**	**5-8**	**9-12**
Evaluation of Project 2061 **teacher** respondents	50	25	31	87	50	53
Evaluation of Project 2061 **leader** respondents	57	90	n/a	86	100	n/a
1993 National Survey of Science and Mathematics Education	3	7	10	9	20	38

On average, the teachers surveyed had more years of experience teaching, and teaching science, than the national average. Table 8 compares the distribution of teachers by their years of teaching experience.

Table 8

Percentage of Respondents by Number of Years Prior Teaching Experience

	Evaluation of Project 2061		1993 National Survey of Science and Mathematics Education		
	All Grade Levels		Grade Level		
	Teacher	**Leader**	**1-4**	**5-8**	**9-12**
Number of years prior experience teaching					
0-10 years	22	31	38	42	35
11-20 years	32	33	43	34	30
> 20 years	48	48	19	24	35
Average	17.9				
Number of years prior experience teaching *science*					
0-10 years	29	40	51	57	43
11-20 years	31	30	34	25	32
> 20 years	40	30	15	19	25
Average	15.6				

The fact that workshop participants are more experienced in classrooms and have had more exposure to science education through coursework and inservice probably reflects the self-selection of teachers who voluntarily attend workshops and conferences. Teachers asked to be on curriculum-writing teams (this was one primary reason for attending) are also likely to be exemplary teachers to whom their districts turned. Similarly, Project 2061 would naturally extend invitations to join the Leaders Network to those who are strong, above-average teachers seeking continued professional growth. Recognizing that Project 2061 has so far reached mainly above-average science teachers, any linking of these results to future strategies aimed at teachers with more typical education and experience levels needs to consider the nature of these participants.

Why Did Participants Attend?

Teacher participants identified two main reasons for attending the workshop: 39% were "involved in curriculum development for school or district," and 34% stated that they were "particularly interested in learning about Project 2061 and *Benchmarks for Science Literacy*." These reasons probably reflect the two main venues at which workshops are conducted. Districts that particularly need to prepare teachers for curriculum development assignments solicit Project 2061 workshops, while workshop participants at NSTA conferences probably attend to satisfy a general interest in current science education reform initiatives that might improve classroom practices. Other reasons for attending the workshop were "wanted to enhance my science teaching skills" (9%) and "scheduled as part of a regular inservice session" (8%).

By contrast, the percentage of leaders attending the workshops was fairly evenly distributed over a number of different reasons, with "invited by Project 2061 staff" the most common reason (21% of the respondents; see Table 9). This variation in respondents' purposes for attending has implications for how the workshop should be structured, what should be featured, and how well workshop activities will or will not meet the participants' needs.

Table 9

Leaders' Reasons for Attending Workshop

Reason	Percentage of Respondents
Invited by Project 2061 staff	21
Believed workshop would aid in my responsibilities for science teacher training	19
Wanted to later lead workshops	17
Particularly interested in learning about Project 2061 and *Benchmarks for Science Literacy*	14
Anticipated that workshop content would be applicable in curriculum development with my school or district	14

What Did Participants Perceive as Benefits of the Workshops?

The vast majority of leaders found the workshop of great overall benefit and stated that they gained concrete skills in learning to use *Benchmarks for Science Literacy* tools. Teacher participants, however, were distributed more evenly in their perceptions of overall benefits. Although teachers gained some specific skills from the workshops, far fewer teachers than leaders reported such benefits. Table 10 indicates overall benefit of the workshop to participants.[9]

Table 10

Overall Benefit of the Workshop to Respondents' Work

Degree of Benefit	Percentage of Teacher Respondents	Percentage of Leader Respondents
No/Little benefit	26	2
Some benefit	38	23
Significant/Major benefit	36	74

Teacher respondents did find the workshop beneficial along specific dimensions. A vast majority of respondents (92%) stated that "increased familiarity with Project 2061

[9] Project 2061 staff themselves also benefited from offering workshops, for example, by staying in touch with the thinking of teachers, teacher leaders, and teacher educators. Although the evaluation did not attempt to measure these benefits, they are nonetheless important.

reform and science literacy concepts" was of some, significant, or major benefit. This benefit is consistent with one of the primary purposes for which teachers attended the workshop, as described in the preceding section.

Teacher reactions to other specific benefits were mixed. Seventy-six percent of teachers said that developing "skills in using *Benchmarks for Science Literacy* to analyze curriculum" was of some, significant, or major benefit. Nevertheless, they needed stronger linkages to translate between the documents and classroom practice. Thirty-nine percent stated that acquiring "new ideas and methods for implementing inquiry-based lessons" was of no or little benefit, and only 42% said that "increased science knowledge" was a benefit of the workshop. A slightly higher percentage (57%) gained some benefit in discovering "resources for augmenting science knowledge" (Exhibit 10).

Teachers expressed some frustration at the generality of the workshop and sought more concrete examples for their classroom practice, both as tools for their own use and also as an effective instructional approach for the Project 2061 presenter to use in training teachers. "I did not feel the workshop made me better able to navigate and use the actual Benchmark document, which was my purpose in attending. It was too general." In other illustrative comments, participants said, "Actual examples of lessons and activities would have been more beneficial. Half a day had passed before we even knew or understood what benchmarks were and what this meant overall." "Provide examples of what it would look like in the classroom. What are the implications at each phase level" [*sic*]. "More time should have been spent on how to use publications/concepts for curriculum development."

Unlike the teacher participants, a large percentage of leaders gained concrete skills in using *Benchmarks for Science Literacy* and translated their experiences into classroom practice. Eighty-eight percent of leaders reported that developing "skills in using *Benchmarks for Science Literacy* to analyze curriculum materials" was of at least some benefit (see Exhibit 11). In contrast to the teacher sample, 83% said that "increased science knowledge" was a benefit of the workshop, and 92% rated at least of some benefit

Exhibit 10
Workshop Benefits to Teachers

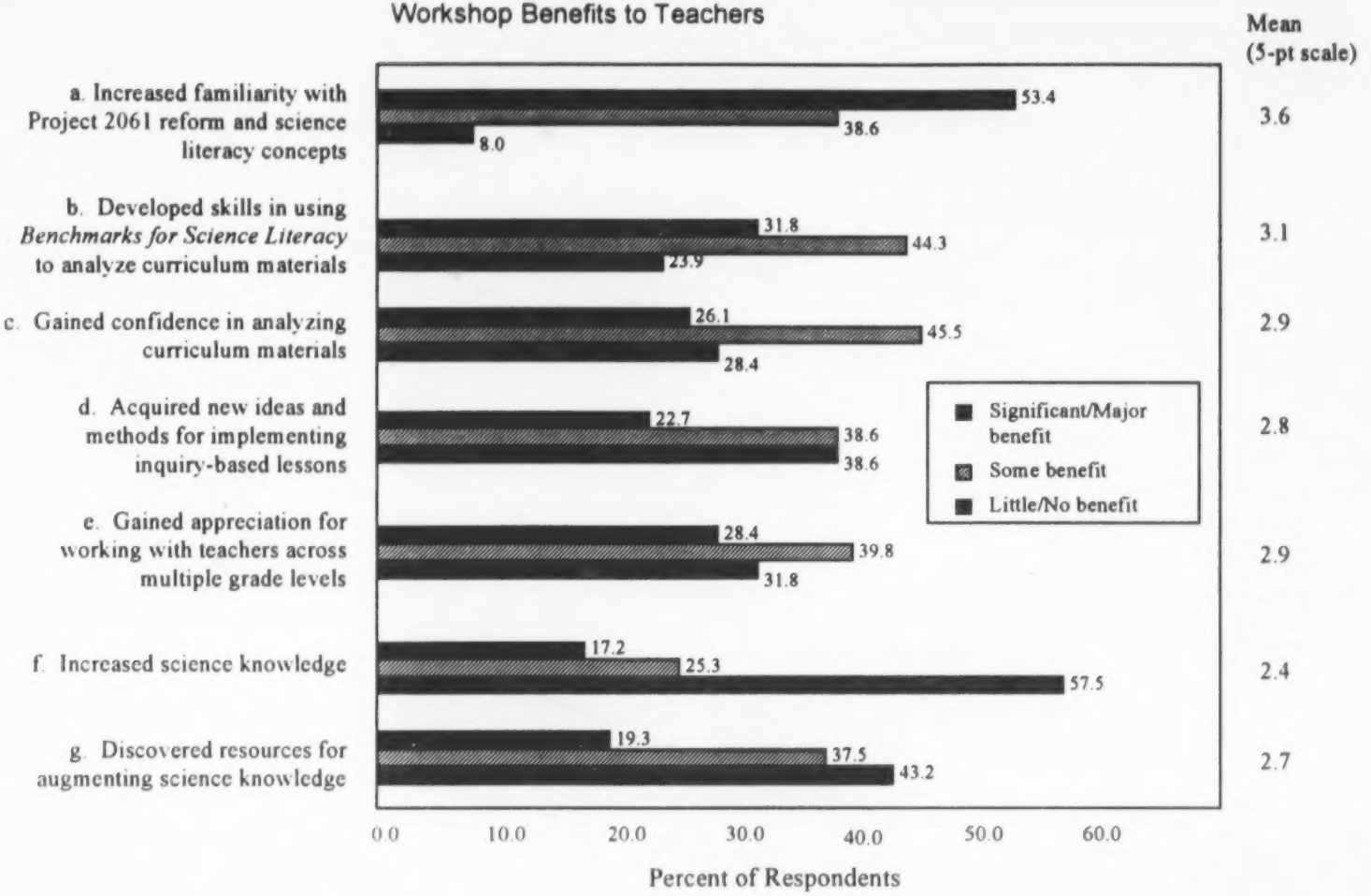

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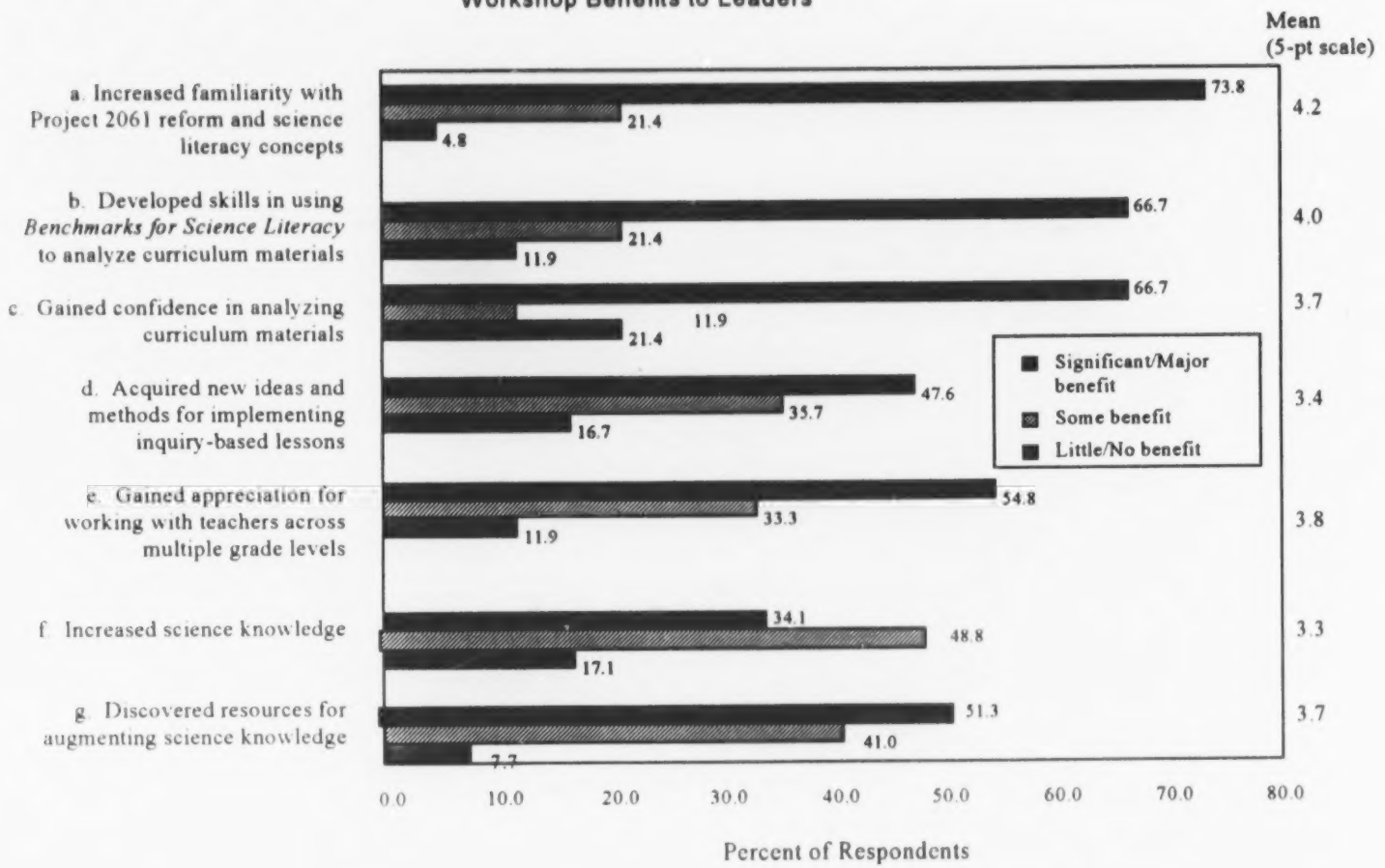
Exhibit 11
Workshop Benefits to Leaders



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the discovery of "resources for augmenting science knowledge." Again, the ability to deliver concrete skills probably requires the kind of intense, multiple-day workshops that the leaders attended.

How Well Did Workshops Convey Project 2061's Key Ideas?

The surveys asked respondents two specific questions about Project 2061 concepts: first, whether they believed that the workshop had clearly and explicitly conveyed individual statements representing key Project 2061 concepts; second, using a five-point scale, the degree to which they agreed with each of those statements.

The Leaders Network workshops (which are of longer duration) appear to be more successful in conveying clearly and explicitly the main Project 2061 ideas. For every statement, a greater percentage of leaders than teachers responded that the statement had been clearly and explicitly conveyed. Leaders workshops appear to be most successful at conveying standards-based reform (Idea a on Table 11), "less is more" (Idea h), and that science teaching should be consistent with the nature of scientific inquiry (Idea j). On the teachers' part, the largest percentage (78%) felt that this latter statement was most clearly conveyed. Relatively few teachers felt that two ideas fundamental to using *Benchmarks* tools, "Careful study of specific learning goals is an important contribution to professional development" (57%) and "Identification of appropriate materials for curriculum and instruction requires detailed study of how they relate to specific learning goals" (55%), were clearly and explicitly conveyed.

Large majorities of leaders strongly agreed with all statements except "Most students are not currently learning science well, even in the best schools" (only 59% strongly agreed). Far fewer teachers strongly agreed with each of the statements. Teachers' strongest beliefs were "Science teaching should be consistent with the nature of scientific inquiry. Characteristics of scientific inquiry include valid evidence, logical reasoning, explaining data, predicting outcomes" (85%), and "Science is inextricably linked to mathematics, social sciences, and technology, and they all should be considered together when planning curriculum and instruction" (73%).

Table 11

Percentage of Respondents Believing Key Ideas were Conveyed Clearly and Percentage of Respondents Agreeing with Ideas

Idea	Idea conveyed clearly and explicitly? Percentage of respondents answering Yes:		To what extent do you agree or disagree with each idea? Percentage of respondents who... ...agree somewhat		...agree strongly	
	Teacher	Leader	Teacher	Leader	Teacher	Leader
a. Changes in the education system should be driven by important, specific goals to be achieved by all students.	68.6	90.7	42.9	11.6	53.6	88.4
b. Most students are not currently learning science well, even in the best schools.	52.3	69.8	43.9	36.6	32.9	58.5
c. Science is inextricably linked to mathematics, social sciences, and technology, and they all should be considered together when planning curriculum and instruction.	66.3	69.8	27.1	9.5	72.9	90.5
d. Science curricula for any grade range should be determined cooperatively by teachers from across the K-12 spectrum, rather than by teachers of the same grade level.	50.0	76.7	32.1	19.0	63.1	78.6
e. The nature of student understanding changes so much during elementary school that distinct learning goals should be specified for both early (K-2) and late (3-5) grades.	47.7	67.4	35.6	17.1	61.6	80.5
f. Students should learn scientific "habits of mind" that explicitly include ways to assess the validity of claims and arguments.	64.0	76.7	30.9	9.3	69.1	90.7
g. Careful study of specific learning goals is an important contribution to professional development.	57.1	79.1	41.8	22.0	57.0	78.0
h. Improving student understanding of science requires reducing in number and detail the science topics in the current curriculum, leaving time for more effective teaching of important ideas.	67.4	97.7	36.9	11.6	60.7	88.4
i. Identification of appropriate materials for curriculum and instruction requires detailed study of how they relate to specific learning goals.	54.7	72.1	42.0	9.5	56.8	88.1
j. Science teaching should be consistent with the nature of scientific inquiry. Characteristics of scientific inquiry include valid evidence, logical reasoning, explaining data, predicting outcomes.	78.2	88.4	14.9	7.0	85.1	93.0

More unfamiliar reform strategies found much less support among teachers. For example, only 54% strongly agreed that "Changes in the education system should be driven by important, specific goals to be achieved by all students," and only 61% strongly agreed with the idea that "less is more" (Idea h). Furthermore, only 57% believe that "Careful study of specific learning goals is an important contribution to professional development," and 57% that "Identification of appropriate materials for curriculum and instruction requires detailed study of how they relate to specific learning goals," whereas 78% and 88% of leaders, respectively, agreed strongly.

The differences in responses between teachers and teacher leaders seem significant. The findings may have implications for which audiences Project 2061 wants to focus on in the future. In addition, the discrepancy in agreement with key Project 2061 statements may have implications for what objectives staff should pursue during workshops. Questions arise, such as whether introducing the *Benchmarks* tools in advance of stronger belief in these ideas is effective and whether it is possible to both convey these ideas and *Benchmarks* tools simultaneously.

Which Factors Influence What Practitioners Teach?

Teachers indicated that a variety of factors contribute to what they teach. Resources such as Project 2061 documents compete for attention with textbooks, the teacher's own science background, the teacher's understanding of how best to teach his or her students, district and state assessments, and district curricula. The results from this survey were consistent with those of the 1993 National Survey of Science and Mathematics (Horizon Research, 1994) (Table 12).

Benchmarks for Science Literacy was released in the same year as the 1993 national survey; however, questions pertaining to the NCTM standards provide some indication of a realistic time frame for such documents to become influential with teachers. Four years after the NCTM standards were released, only 24% of grades 1-4 teachers, 43% of grades 5-8 mathematics teachers, and 54% of grades 9-12 mathematics teachers reported that the

NCTM *Curriculum and Evaluation Standards* had a major influence on what they taught (Horizon Research, 1994).

Table 12

Science Classes Where Teachers Report That Various Factors Have a Major Influence on What They Teach (National Frequencies)*

	Percent of Classes		
Influence	Grades 1-4	Grades 5-8	Grades 9-12
Your own understanding of what motivates your students	92	94	89
Your own science content background	82	83	91
Your district's curriculum framework/course of study	79	74	62
Available laboratory facilities, equipment, and supplies	75	84	91
Your state's curriculum framework/course of study	64	61	51
Textbook	53	66	69
Parents/community	41	37	33
State test	27	33	25
District test	22	24	15
Scope, Sequence, and Coordination	12	18	10
Science for All Americans	4	8	7

* "Teachers were given a four-point scale for each factor, with 1 labeled as 'no influence' and 4 labeled 'extensive influence.' These percentages include the total circling either 3 or 4." Weiss, I., M. C. Matti, and P. S. Smith, *Report of the 1993 National Survey of Science and Mathematics Education*, Horizon Research, 1994, p. 72.

Despite the modest levels of influence and benefit of the workshops reported by teachers, they appear to use the document itself. According to the workshop survey, *Benchmarks for Science Literacy* exerts significant or major influence on a comparable percentage of responding teachers (44%) as do current textbooks (42%). Another 41% of teachers reported that *Benchmarks for Science Literacy* has some influence on what they teach. Only 27% of teachers stated that *Science for All Americans* is of significant or major influence, but 46% rated it of some influence. The *National Science Education Standards* are a significant or major influence on what 35% of respondents teach and some influence on another 42%. Far fewer teachers said *Scope, Sequence, and*

Coordination influences what they teach: 41% of teachers said it has little or no influence on what they teach. See Exhibit 12 for influences on what teachers teach.

Such relatively strong reports of the influence of documents appear to exceed workshop impacts. One explanation may be that the document is the main tangible item that teachers receive from the workshop. (Indeed, demands for more take-home materials indicate that these resources may increase in usefulness and value as participants revisit the documents over time.) Acquiring increased knowledge of Project 2061 may have been sufficient to inspire teachers to peruse *Benchmarks* on their own time, and its appeal may account for the comparable influence of *Benchmarks* and textbooks. Also, the reported strong influence of *Benchmarks* may reflect the experiences of teachers on curriculum framework writing teams. Of all the teachers who rated *Benchmarks* of significant or major influence, 49% were on district curriculum writing teams; this was also true of 57% who rated *SFAA* of significant or major influence.

The influence of Project 2061 documents on determining what the leaders teach is more dramatic than that for teachers. Eighty-eight percent of leaders stated that *Benchmarks for Science Literacy* exerts a significant or major influence, and 78% said that *Science for All Americans* has a significant or major influence on what they teach. The *National Science Education Standards* has a significant or major influence on only 36% of teacher leaders. A mere 11% of leaders said their current textbook has significant or major influence on what they teach. Similarly, fewer leaders than teacher respondents said their own science content background (62%), their own understanding of what motivates their students (54%), or available laboratory facilities, equipment, and supplies (62%) has a significant or major influence on what they teach. See Exhibit 13 for influences on what leaders teach.

Teachers and leaders reported that they have continued to use Project 2061 documents, although more leaders report doing so. Both teachers and leaders write that

Exhibit 12
Influences on What Teacher Respondents Teach

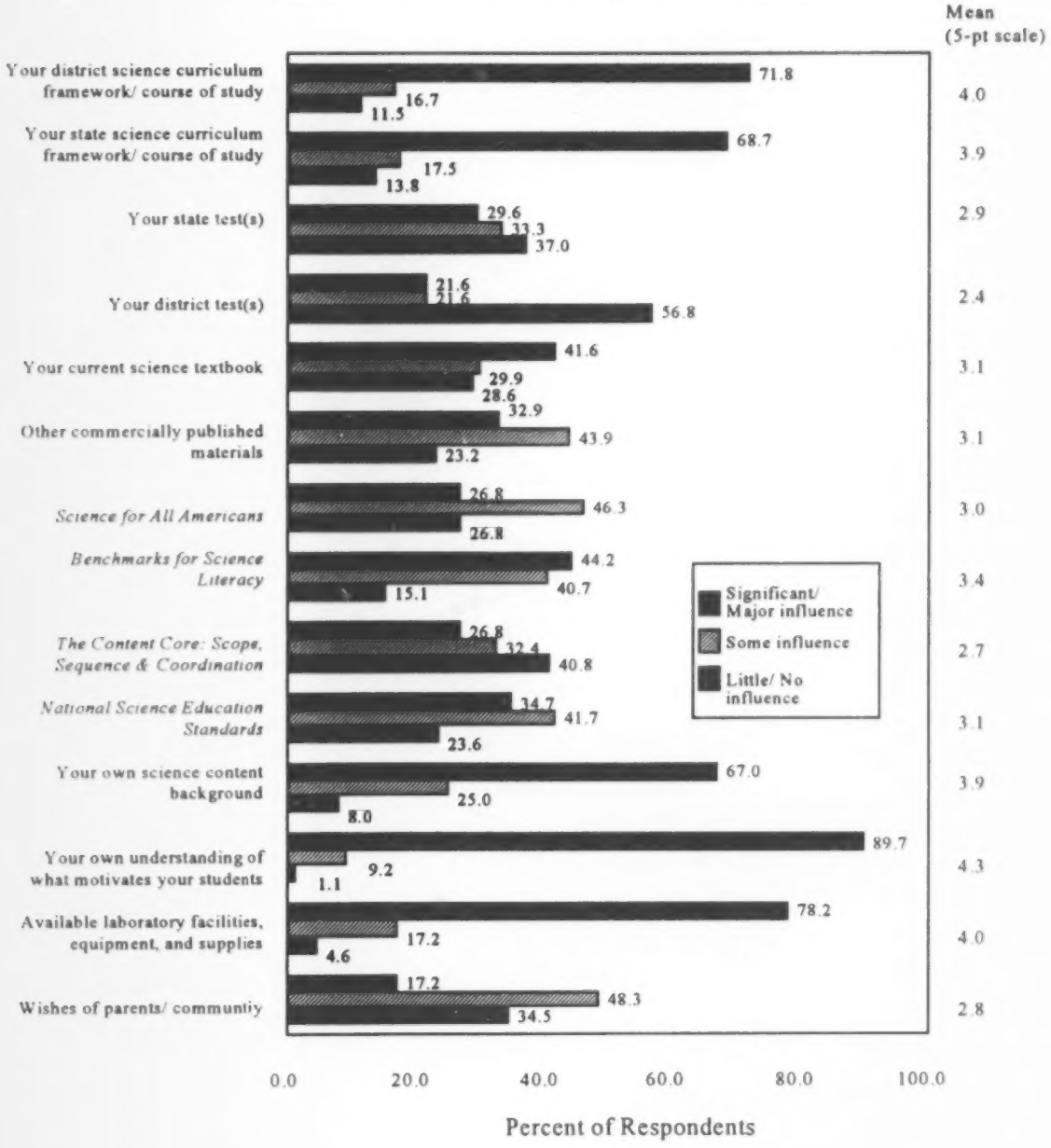
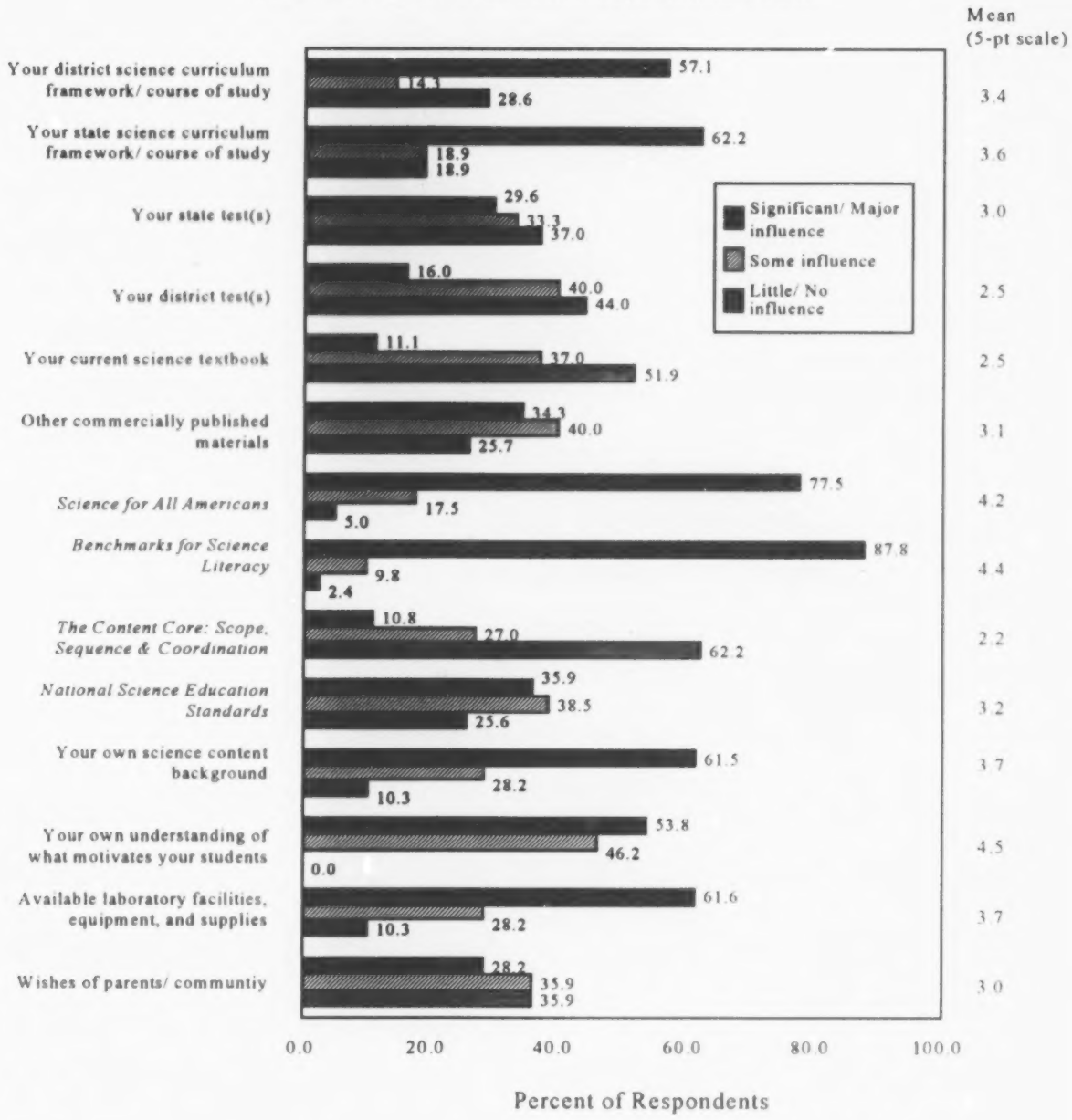


Exhibit 13
Influences on What Leader Respondents Teach



they use *Benchmarks* as a reference guide for the "big ideas" or themes for units that they teach. Far more common, however, are teachers and leaders who report that they are participating on the district curriculum writing team and use *Benchmarks for Science Literacy* specifically for writing curriculum. "As we continue to refine our own local science curriculum I use the *Benchmarks* as the reference point for our work with the new [state] science and math framework."

Did Workshops Influence Professional Practices?

Teachers reported that the major benefit of the workshops was acquiring an overview of Project 2061, rather than learning specific skills. Nonetheless, when asked to compare their practices before the workshop with their current practices, they reported modest changes.[10] (Tables 13 and 14 state the percentages of teachers estimating the frequency of specific practices before and after the workshop.)

Table 13

Teachers Who Report Engaging in Specific Teaching Practices

	"Very Often"			"Never" or "Rarely"		
Practice	**Before Workshop**	**After Workshop**	***Difference***	**Before Workshop**	**After Workshop**	***Difference***
"Evaluate lesson plans in terms of what students will actually learn"	26%	35%	*+9*	21%	19%	*-2*
"Participate in curriculum writing team for school or district"	35	36	*+1*	33	38	*+5*
"Refer to outside resources for new science knowledge"	47	51	*+4*	14	9	*-5*

[10] In four separate questions, teacher and leader respondents were asked how often they engaged in a number of instructional practices "prior to the workshop" and "as a result of the workshop." The scale respondents used was "Never," "Rarely," "Occasionally," "Often," and "Very Often" for the questions summarized in Tables 13 and 15, and "Almost Never," "Once a Month," "2-3 Times a Month," "Once a Week," and "Almost Every Class" for the questions summarized in Tables 14 and 16.

Table 14

Teachers Who Report Engaging in Specific Teaching Practices (continued)

Practice	"Almost Every Class"			"3x/Month" or Less		
	Before Work-shop	After Work-shop	*Differ-ence*	Before Work-shop	After Work-shop	*Differ-ence*
"Use student discussion and inquiry in class"	58%	66%	*+8*	12%	7%	*-5*
"Incorporate more hands-on activities"	41	48	*+7*	12	8	*-4*
"Probe and address students' preconceptions about science topics"	37	45	*+8*	33	18	*-15*

Along most dimensions measured, larger percentages of leaders than teachers appear to have changed their classroom practices as a result of the summer workshops. The greatest changes occurred in the percentage of leaders who very often "evaluate lesson plans in terms of what students will actually learn" (+40%) and "probe and address students' preconceptions about science topics" (+31%). (See Tables 15 and 16.)

Table 15

Leaders Who Report Engaging in Specific Teaching Practices

Practice	"Very Often"			"Never" or "Rarely"		
	Before Work-shop	After Work-shop	*Differ-ence*	Before Work-shop	After Work-shop	*Differ-ence*
"Evaluate lesson plans in terms of what students will actually learn"	20%	60%	*+40*	34%	5%	*-29*
"Participate in curriculum writing team for school or district"	40	46	*+6*	28	31	*+3*
"Refer to outside resources for new science knowledge"	44	70	*+26*	24	10	*-14*

Table 16

Leaders Who Report Engaging in Specific Teaching Practices (continued)

Practice	"Almost Every Class"			"3x/Month" or Less		
	Before Work-shop	After Work-shop	*Differ-ence*	Before Work-shop	After Work-shop	*Differ-ence*
"Use student discussion and inquiry in class"	69%	83%	*+14*	11%	0%	*-11*
"Incorporate more hands-on activities"	64	85	*+21*	6	0	*-6*
"Probe and address students' preconceptions about science topics"	41	72	*+31*	32	8	*-24*

Overall, these findings suggest that the workshop appears to have instigated significant changes in leaders' teaching practices along the above dimensions.

Do the Leaders Use the Training?

A high percentage of leaders report engaging in activities to train others. Ninety-one percent of respondents have informally shared with their colleagues knowledge from the workshop, and 81% have offered formal training sessions. Leaders have conducted sessions at their own schools, within their districts, or outside their districts. Forty-four percent of respondents have offered four or more sessions within their own districts and 44% offered sessions outside their districts. Despite these individual efforts, the scale of activity is very low since the cadre of leaders numbers only 69 over the 2 years.

Sixty-eight percent of leaders planned to conduct more training, but only 27% had sessions scheduled. Leaders expressed a need for more support from their administration to offer training. They feel that they are untapped resources for the district and for Project 2061. The main reason they had not offered more training was a perceived lack of interest among colleagues and district administration: "Lack of requests for workshops. My school district was rewriting their local standards to be better aligned to the benchmarks, but has not solicited any assistance." The leaders see Project 2061 as

playing a larger role in creating interest and support from administrators, such as undertaking some marketing effort directed at the local administrators of the leaders' districts.

Finally, leaders expressed a desire for a forum to strengthen the network they began to build with other leaders during the summer. When asked what could be improved, many responded similarly: "Establish a network for the leaders that allows an exchange of ideas, formats, etc."

Results of the Teacher Educator Survey

Who Attended the Workshops?

The vast majority of teacher educator participants work at institutions of higher education (IHEs). Of the 86% who are members of IHEs, 59% are professors. Thirty-seven percent are appointed to science departments and 40% to the education faculty. Thus, the results combine perspectives from both preservice teacher education and the science disciplines.

Why Did Participants Attend?

Participants identified three main reasons for attending the workshop: "Invited to attend" (23%); "Was/am participating in State Systemic Initiative (SSI) or other education reform project" (20%); "Want to improve teachers' preservice or inservice science education" (18%). These purposes are expectedly different from those that teachers and leaders reported. In addition to being invited for purposes of the Project 2061 agenda, these participants are involved in larger reform initiatives and approach Project 2061 from the view of contributing to teacher professional development rather than solely their own personal development.

What Did Participants Perceive as Benefits of the Workshops?

Overall, teacher educators found their workshops beneficial: 47% found the workshop of significant or major benefit, 41% of some benefit, and only 12% of little or no benefit.

An "increased familiarity with Project 2061 reform and science literacy concepts" was of at least some benefit to more educators than any other aspect of the workshop (90%). Respondents were mixed in their responses to other specific benefits. (Exhibit 14 illustrates benefits educators derived from the workshop.). The percentage of respondents receiving these benefits is lower than those among teachers and leaders primarily because of the deeper science background of the educators, the different orientation toward professional development rather than K-12 practice, and a likely difference in workshop focus.

Overall, the greatest benefit that respondents expressed was the opportunity to discuss science education reform with colleagues from many backgrounds. Debate, discussion, and networking with those within the same teacher education field or a related field were repeatedly reported as the most useful aspects of the workshop. "Listening to professionals outside of my field respond to the reforms"; "Interactions with people from different educational realms"; "The opportunity to meet with other instructors and share ideas and dilemmas" were typical comments when participants reported what they found most useful about the workshop. Reallocating workshop time to allow more of such discussions was also a common suggestion.

How Well Did Workshops Convey Project 2061's Key Ideas?

Teacher educators expressed an overwhelming agreement with the ideas expressed by Project 2061, but provided mixed responses on the clarity of the messages as conveyed in the workshops (Table 17). For example, only 44% of educators believed that the idea that "Science is inextricably linked to mathematics, social sciences, and technology, and they all should be considered together when planning curriculum and instruction" was clearly and explicitly conveyed, although 72% agreed strongly with the statement. Similarly, only 52% thought "Identification of appropriate materials for curriculum and instruction requires detailed study of how they relate to specific learning goals" was clearly and explicitly conveyed, though 74% strongly agreed with it. Again, this in all likelihood reflects a different workshop emphasis than the emphasis in the workshops that Project 2061 staff offer to leaders and teachers.

Exhibit 14
Workshop Benefits to Educators

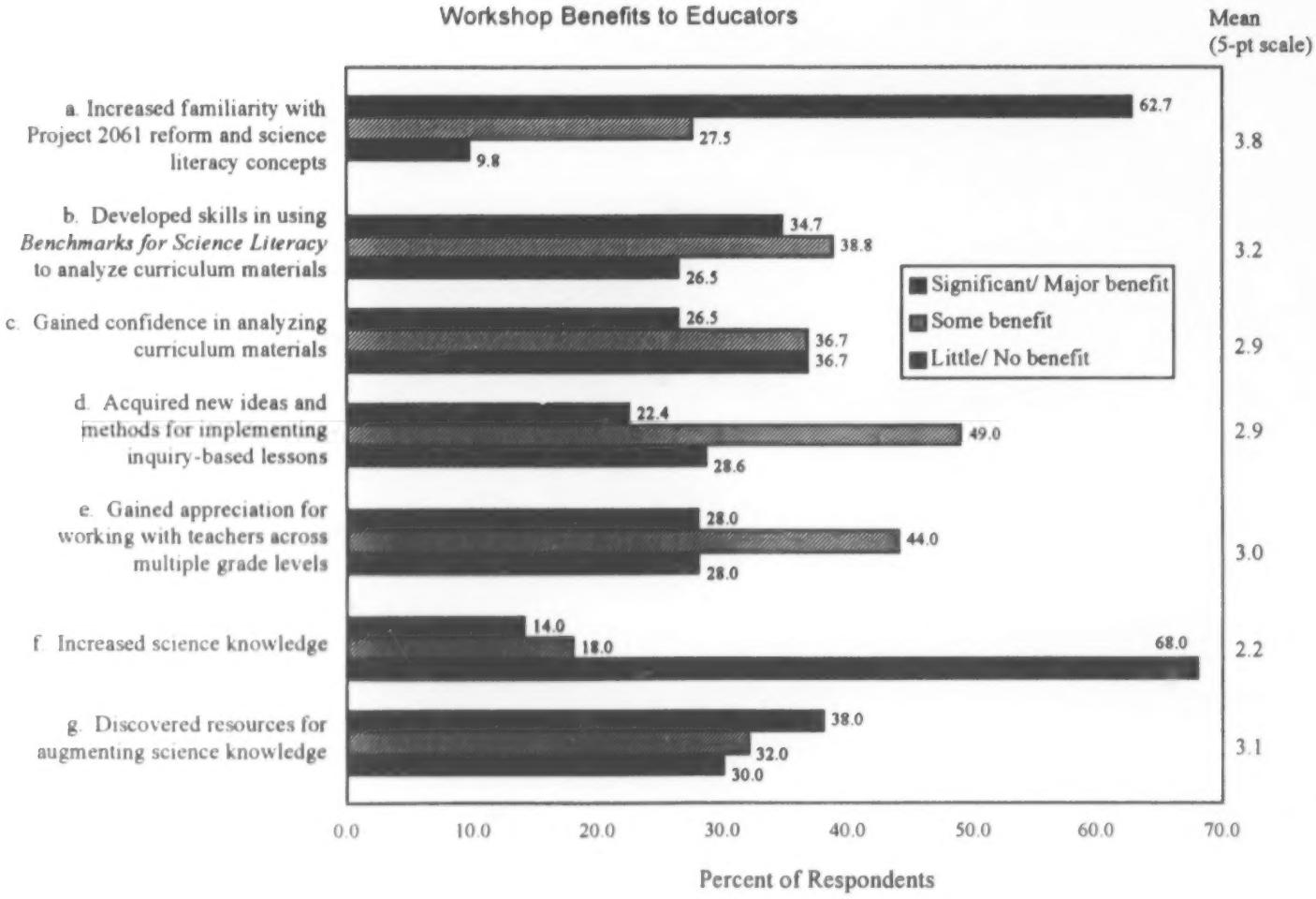


Table 17

Percentage of Respondents Believing Key Ideas Were Conveyed Clearly, and Percentage of Respondents Agreeing with Ideas

	Percent of respondents answering Yes:	To what extent do you agree or disagree with the statement? Percent of respondents who...	
Idea	**Idea conveyed clearly and explicitly**	**... agree somewhat**	**...agree strongly**
a. Changes in the education system should be driven by important, specific goals to be achieved by all students.	78.0	27.7	63.8
b. Most students are not currently learning science well, even in the best schools.	52.0	39.1	52.2
c. Science is inextricably linked to mathematics, social sciences, and technology, and they all should be considered together when planning curriculum and instruction.	44.0	25.5	72.3
d. Science curricula for any grade range should be determined cooperatively by teachers from across the K-12 spectrum, rather than by teachers of the same grade level.	44.0	29.2	64.6
e. The nature of student understanding changes so much during elementary school that distinct learning goals should be specified for both early (K-2) and late (3-5) grades.	30.0	42.2	55.6
f. Students should learn scientific "habits of mind" that explicitly include ways to assess the validity of claims and arguments.	64.0	15.2	84.8
g. Careful study of specific learning goals is an important contribution to professional development.	50.0	28.3	71.7
h. Improving student understanding of science requires reducing in number and detail the science topics in the current curriculum, leaving time for more effective teaching of important ideas.	78.0	20.8	75.0
i. Identification of appropriate materials for curriculum and instruction requires detailed study of how they relate to specific learning goals.	52.0	23.9	73.9
j. Science teaching should be consistent with the nature of scientific inquiry. Characteristics of scientific inquiry include valid evidence, logical reasoning, explaining data, predicting outcomes.	68.0	12.2	83.7

The perceived lack of clarity and explicitness of these messages was compounded by a general confusion about the objective of the workshops. Although the educator workshop was slightly different than standard *Benchmarks* workshops, the respondents did not feel that the activities were sufficiently targeted at the audience, their needs, and their potential contributions. When asked how the workshop could be improved, respondents declared: "They should have set about helping the roomful of highly capable people collaboratively develop approaches to improve their work. Instead, they wasted their time." "Too much time was spent on low information context activity." "Keep the pace going. Clearly defined short tasks and then reflection."

Which Documents Do Teacher Educators Use in Their Practice?

Educators demonstrate a commitment to standards-based reform and validate the importance of national standards through their use of such documents with their preservice teachers. When asked which documents educators use in their practice, the highest percentages of respondents said they use *SFAA* (92%), *Benchmarks for Science Literacy* (90%), the *National Science Education Standards* (89%), state science curriculum frameworks or standards (88%), and relevant or exemplary district science curriculum frameworks (75%). Of these documents, 77% rated state science curriculum frameworks of high importance, 77% *Benchmarks for Science Literacy*, 76% the *National Science Education Standards*, and 71% *Science for All Americans*.

Higher percentages of respondents encourage their students to use these documents than use the documents in their own work (Table 18). Some teacher educators clearly find the standards-based documents important components of preservice education, suggesting that they play a role in defining the curriculum for preservice science teachers: "It is crucial that Project 2061 documents be a core part of every K-8 teacher's preservice program," and "All K-12 science teachers should have a detailed understanding of the ideals of Project 2061." Others have a more tempered view of the documents' importance: "Many of the courses are being rethought because of *SFAA* and *Benchmarks*, but the courses do not necessarily base everything on these publications."

Table 18

Influences on Teacher Educators

	Percentage of respondents answering Yes	Percentage of respondents answering items as...		Percentage of respondents answering Yes
Document	Use these for own purposes	...Medium importance	...High importance	Encourage student teachers to study these
a. Relevant or exemplary district science curriculum frameworks	75.0	32.5	52.5	83.9
b. State science curriculum framework or standards	87.8	18.2	77.3	93.9
c. State or district tests	46.8	41.9	32.3	42.3
d. Science textbooks	81.6	44.4	35.6	94.1
e. Other commercially published curriculum materials	89.8	42.2	57.8	97.1
f. *Science for All Americans* (AAAS, 1989)	92.3	29.2	70.8	88.6
g. *Benchmarks for Science Literacy*	90.4	21.3	76.6	91.4
h. *The Content Core: Scope, Sequence and Coordination*	40.0	29.4	20.6	37.0
I. *National Science Education Standards*	88.5	20.0	75.6	91.2

This tempered view is borne out by the comparable percentages of teacher educators who use science textbooks (82%) and other commercially published curriculum materials (90%). It is unclear how textbooks and other commercial materials are used—whether as factual reference material, as units of analyses, or for other purposes.

Did Workshops Influence Professional Practices?

The survey responses do not suggest that substantial change in practices occurred among teacher educator participants as a direct result of the workshops.[11] The most notable change was the exposure to *Benchmarks for Science Literacy* and the apparent increase in the perceived value of the *Benchmarks*. The percentage of respondents who never or rarely "refer my student teachers to *Benchmarks for Science Literacy*" decreased from 41% to 13%, while the percentage of respondents who do so very often increased from 23% to 32%. Also, the percentage of respondents who never or rarely "refer my student teachers to *Science for All Americans*" decreased from 29% to 13% (Table 19).

Other changes included the percentage of respondents who very often "[were] reflective about pedagogy" increased slightly from 65% to 73%, and the percentage of respondents who very often "evaluate my own lesson plans in terms of what students will actually learn" also increased slightly from 53% to 59%.

In reflecting on Project 2061's role, educators responded that thinking on Project 2061's application to higher education is incomplete. Although they saw great potential for Project 2061 to influence the course of postsecondary science education and preservice science teacher education, they seemed frustrated at the lack of attention given to higher education issues. "Have to be more specific in the way in which we can train teachers. I still see a lot of problems between *Science for All Americans* and *Benchmarks* and teacher education," and "Project 2061 needs to infiltrate the colleges and universities who serve as role models for teaching science.... [Having] subject matter facts

[11] In four separate questions, teacher educator respondents were asked how often they engaged in a number of instructional practices "prior to the workshop" and "as a result of the workshop." The scale respondents used was "Never," "Rarely," "Occasionally," "Often," and "Very Often" for the questions summarized in Table 19, and "Almost Never," "Once a Month," "2-3 Times a Month," "Once a Week," and "Almost Every Class" for the questions summarized in Table 20.

[presented] with lecture methods [as opposed to inquiry-based methods] makes it difficult for prospective teachers to implement Project 2061" are two expressions of this perceived need.

Table 19

Teacher Educators Who Report Engaging in Specific Teaching Practices

	"Very Often"			"Never" or "Rarely"		
Practice	**Before Work-shop**	**After Work-shop**	***Differ-ence***	**Before Work-shop**	**After Work-shop**	***Differ-ence***
"Evaluate prospective teachers' lesson plans in terms of what students will actually learn"	53%	57%	*+4*	9%	7%	*-2*
"Refer my student teachers to *Benchmarks for Science Literacy*"	24	32	*+8*	41	13	*-28*
"Refer my student teachers to *Science for All Americans*"	29	32	*+3*	29	13	*-16*
"Evaluate my own lesson plans in terms of what students will actually learn"	53	60	*+7*	4	5	*+1*
"Was reflective about pedagogy"	65	73	*+8*	0	2	*+2*

Table 20

Teacher Educators Who Report Engaging in Specific Teaching Practices (continued)

	"Almost Every Class"			"3x/month" or Less		
Practice	**Before Work-shop**	**After Work-shop**	***Differ-ence***	**Before Work-shop**	**After Work-shop**	***Differ-ence***
"Use *Science for All Americans* and *Benchmarks for Science Literacy* in class"	11%	2%	*-9*	76%	76%	*0*
"Use student discussion and inquiry in class"	63	61	*-2*	23	23	*0*
"Incorporate more hands-on activities"	52	50	*-2*	31	27	*-4*

Participants' Reflections on Workshops

Finally, other suggestions for improvement centered around time and time allocation, organization and presentation of the workshop, and targeting the workshop agenda to the audience. Participants from all audiences stated that either the workshop activities required more time, that the workshop attempted to do too much within the specified time, or that the time that was available could have been better allocated among the activities. On this latter point, teachers and educators differed. Whereas teachers (who typically attended the shortest of the workshops) would have preferred more hands-on activities and a less lecture-type format, educators would have preferred fewer or shorter hands-on activities and more group discussion. Although the rushed nature of the workshop led to some frustration, the demand for more time seemed to stem from an interest in Project 2061 and a desire to learn how to use the *Benchmarks* tools.

Responses to the question seeking suggestions for improvement expressed a need for better organization of the workshops or singled out the presenters as an aspect for improvement. These suggestions centered around the prosaic: being set up on time, providing hand outs and books as promised, and presenting in a more dynamic fashion.

Written responses also indicated that better targeting of each workshop to its particular audience would have improved the workshops. Specifically, workshop formats need to reflect differing needs between teachers and teacher educators, including inservice providers. Workshops also need to recognize the differences in prior knowledge of Project 2061 among audience participants. Some participants with knowledge of the Project 2061 documents who were seeking some explicit uses of the *Benchmarks* tools were disappointed at the introductory nature of the workshops.

The findings reported here must be interpreted in light of whom the workshops touched. Arguably, the above-average nature of its teacher participants (in terms of formal science education background, years of experience teaching, and level of inservice activity) may represent the most appropriate type of teacher to whom Project 2061 should broadcast its message. These teachers may be more reflective, more innovative, more open to new ways to improve their practices. The readiness and willingness of teachers to

reflect on and change practice is an important consideration, given the limited capacity of Project 2061 to approach teachers on a large scale.

One further caution centers around the beliefs teachers revealed in the survey. When one notes that only 61% of teachers strongly agree that the level of detail taught to students must be reduced, this is cause for real concern. Considering that a much smaller percentage of the teachers who did not attend Project 2061 workshops are likely to agree, the data suggest that there is much work to be done if teachers' classroom practice is to become consistent with the philosophy that "less is more." Furthermore, only 54% of teachers strongly agree that education system reform should be driven by specific goals for all students. This would be consistent with the findings from the expert review of textbooks reported in Chapter 2, and with the claim of publishers that teachers as a group, particularly those at the high school level, are unwilling to discard much of the content that is now taught and do not, as yet, fully embrace standards-based reform efforts.

V. REFLECTIONS AND RECOMMENDATIONS

The preceding chapters have reported on the impacts of Project 2061's two key documents at the national level and in the states, as well as the impacts of workshops conducted by Project 2061 staff. They show that during its first 10 years Project 2061 has been highly productive, publishing key documents that were very timely and that found almost immediate application both at the national level (e.g., as an aid to developing the *National Science Education Standards*) and at the state level (especially to develop state science curriculum frameworks).

If Project 2061 were to cease operation, it would have an enviable track record to show for itself. But ceasing operation would not be compatible with the idea of helping to bring about long-term change, nor, as is documented in the case studies, has the education system reached a point where all the necessary strategies are in place, the tools are available, and reform is inevitable. Thus, leaders of the Project are faced with the question of what future initiatives would continue to make a significant contribution to science education reform. Some of the evaluation findings may prove useful to inform these choices.

Reflections on the Impacts of Project 2061

Future initiatives and strategies to increase the impact of Project 2061 will build on both its accomplishments to date and on an understanding of the barriers or limits that Project 2061 has encountered. Many of the barriers facing Project 2061, such as the unpredictable impact of state politics, also confront the designers of any ambitious, large-scale science education reform initiative. Encountering obstacles is inevitable, since they are due to the intrinsic difficulty of changing such a large, complex enterprise as American education.

Among the key national groups identified for the evaluation, those that developed the *National Science Education Standards* and others developing state curriculum frameworks have used the documents most extensively. To date, science curriculum

materials developers have made far less constructive use of the documents. At the local level, there is some direct use of Project 2061 documents (for example, several districts in Georgia use *Benchmarks* to assist in selecting textbooks). However, the evaluation data show that serious constraints govern the process of systemic reform in states, districts, and schools.

These findings suggest that, having made a major impact on science standards and frameworks, it may now be constructive for Project 2061 to focus on other components of the education system where progress is needed. Systems for assessing students' learning and for developing (and adopting) science instructional materials are examples.

Future Project 2061 initiatives might also be designed in light of the skepticism of teachers and certain leadership groups (notably leaders of state science teacher professional organizations) about the usefulness of any national documents. It appears that the closer the groups are to the classroom, the less likely they are to know how to directly use national reform documents well and the more they are likely to rely on state and local documents; at the same time, the number of national reform documents is growing, even in the field of science education. These facts suggest that some state and local leadership groups might appropriately be targeted for special attention. A joint effort by science education reformers to address and work with such skeptical leadership groups may increase the chance that successes at the state level will translate into successes in schools and classrooms.

The large majority of participants report that they found Project 2061's workshops to be beneficial. However, Project 2061 cannot provide workshops to all who might benefit from them. Indeed, the potential number of teachers that Project 2061 might want to reach is so large that the impact of reaching a few hundred a year (as at present) is not likely to be great, regardless of how effectively that might be done. In contrast, the impacts of past workshops on teacher leaders and on preservice teacher educators seem to be much more positive than those of the workshops for teachers, and workshops for leadership groups have the potential to affect a large secondary group who come in contact with the leaders. In the case of workshops for teacher educators, an important

secondary group includes prospective teachers of science currently enrolled in institutions of higher education, many of whom will need guidance before they can effectively teach science.

These reflections suggest various paths that Project 2061 might follow in the future. However, before attempting to identify specific strategies or initiatives that may be worthy of support from Project 2061, it will be useful to consider criteria by which to judge suggestions. What types of principles might guide the selection of new initiatives by Project 2061?

Assessing Future Initiatives for Project 2061

Criteria for Selecting New Project 2061 Initiatives

There are many ideas in science education, and at any time there are hundreds of reform projects under way with support from a variety of sponsors. On the basis of the evaluation findings, information about Project 2061, and knowledge of the education reform process, seven key criteria are listed below that Project 2061's leadership might consider as they decide which initiatives are best suited to be conducted in the future:

1. **Address problem areas where the opportunities are great.** Project 2061 is not a large organization, and its budget is more likely to be stable, or shrink, than it is to grow dramatically. Under these circumstances, Project 2061 must place its bets carefully, investing in problem areas with high needs, where action will be timely, and where other organizations are not likely to make such a significant contribution.

2. **Make use of the scientific and educational expertise of AAAS.** Project 2061 should build on the strengths of its sponsoring organization. As part of the American Association for the Advancement of Science, Project 2061 can easily draw on a great array of scientific and technical expertise. AAAS also has a lot of expertise in science education in particular domains. (Some education issues, such as equalization of fiscal resources available to districts and schools, although important, are not within 2061's current expertise.)

3. **Be well matched to the amount of resources (budget and staff) available.** There is a danger of being "stretched too thin" that Project 2061 should avoid. *Science for All Americans* and *Benchmarks* are seen as being of high quality, and quality should remain a hallmark of Project 2061's work. The number of Project 2061 initiatives must therefore be limited.

4. **Make use of, and leverage, existing networks working in science education reform.** There has been for some years a tremendous amount of activity in science education across the United States. To the extent that Project 2061 can transfer key ideas into professional networks already in place, and influence the thinking of people in those networks, it will be able to leverage its impacts. Conversely, without support from and within such networks, reform will be far more difficult.

5. **Be designed to survive political realities at the state and federal levels.** One of the harsh lessons learned from the NSF Statewide Systemic Initiatives (SSIs), from the creation of national history standards, and from other recent education initiatives is that federal and state politics can have enormous impacts on education reform, and can undo years of hard work very rapidly. No initiative can be designed to be perfectly safe, but Project 2061 should consider political realities carefully as it creates the strategies for its future activities.

6. **Be consistent, and be *perceived* as consistent, with the *National Science Education Standards*.** To date, according to the data gathered for this evaluation, the fact that three organizations (AAAS, NAS/NRC, and NSTA) have been leading separate projects to define a national approach to science education reform has not generated much confusion. Yet there is still a real risk that confusion or disagreements may grow and become a barrier to science education reform. This would be a serious problem. Project 2061 should take steps (as it has before) to maximize consistency with the *National Science Education Standards*, and to maintain a unified, coordinated national reform effort.

7. **Build on the successes of *Science for All Americans* and *Benchmarks for Science Literacy*.** Although it is possible to conceive of useful initiatives unrelated to these two efforts, it is unclear that Project 2061 would be the appropriate organization to carry out such initiatives. These two documents have helped provide momentum to the science education reform movement, but the work is by no means done.

Combining these criteria with the findings from the evaluation leads to a number of options for Project 2061 to consider as future initiatives. These are discussed in the next section.

Options for Future Project 2061 Initiatives

This evaluation has found evidence that there are opportunities for Project 2061 in at least three broad areas. First, the case studies show that some components of standards-based reform still require a great deal of work before they can be incentives for change rather than barriers. Thus, Project 2061 could profitably continue to work on certain key components of standards-based reform (and already has plans to do so). In addition, the Project can create initiatives with starting points in the K-12 education system other than specific components of systemic reform (such as curriculum frameworks); an example of such a starting point is the existing networks of science education reformers and experts. Finally, Project 2061 could focus more of its efforts on institutions of higher education, which are not part of the K-12 education system, per se. These three areas are discussed in turn below.

Key components of standards-based reform. The evidence shows that Project 2061 has already made a significant contribution to the creation of the *National Science Education Standards* and, in many states, to the creation of high-quality science curriculum frameworks. Both the standards and the frameworks play important roles in standards-based or systemic reform. Which other components of systemic reform may be especially "ripe" for work by Project 2061?

- ***Textbooks.*** The evidence suggests that science textbooks are changing slowly, at best, and that more changes are at a superficial than at a deep level. Yet textbooks are central to what happens in many classrooms. Project 2061 is developing curriculum analysis tools that may be useful to state and district textbook adoption committees, or to others who need to understand what is or is not in science textbooks. The evidence suggests that this is an area of high need. Clearly, it is also an area that builds on Project 2061's strengths, including its prior work.

  Project 2061 recently participated in a meeting convened by the National Research Council to work with textbook publishers and provide more information to them about the *National Science Education Standards*. As suggested in Chapter II, there appear to be other opportunities to work directly with the publishers. Even simple and inexpensive actions, such as providing them with Project 2061 newsletters, *Benchmarks on Disk*, and new publications that emerge in the future, may pay rich dividends. Convening a meeting to discuss with publishers the use of the new curriculum analysis tool is another

possibility worth considering. Whatever is done here must recognize the market-driven culture of the publishers' world, if it is to gain their respect. Clearly, however, national standards and the *Benchmarks* can now be considered influences in the marketplace, and publishers cannot ignore them.

A recent report on NSF's Statewide Systemic Initiatives Program identified the area of high school science as one in which people's visions of reform classrooms seems especially limited (Zucker et al., 1995). Therefore, special efforts may be needed to convince teachers, publishers, state policy-makers, parents, and others that "less is more" really has validity in high schools. Some efforts (such as *ChemCom*) that focus on teaching for understanding (rather than on teaching massive amounts of detail) have not yet been widely accepted. If Project 2061 were able to work with policy-makers in selected districts or states to demonstrate that dramatic change in a textbook used at the high school level is *marketable* on a larger scale, publishers might take note.

- ***Assessments.*** As noted in Chapter IV, state assessments of student learning that are poorly aligned with national standards are a serious obstacle to reform. There may be important opportunities for Project 2061 to apply its expertise about content knowledge and education standards to state policies with respect to assessments. One possibility would be to create a tool, similar to the one being developed for curriculum, that would be used instead to analyze assessments. Another possibility would be to join forces with other groups that are working to improve state assessments, including the New Standards project or SCASS (operated by the Council of Chief State School Officers). The National Science Foundation is beginning to invest more of its resources in this area, and might be a strategic partner, a funder, or both.

Other leverage points in the K-12 education system. Reform can be promoted not only through a focus on components of systemic reform, such as setting standards or developing assessments. A focus on people or on technology might also be productive.

- ***Professional networks.*** Project 2061 has worked with a variety of existing professional networks (for example, the Council of State Science Supervisors, the principal investigators of the SSIs and of the NSF Collaboratives for Excellence in Teacher Preparation, staff of the Eisenhower Regional Consortia), and this seems a wise investment of time and resources. These efforts can have great multiplier effects. Reform often depends on strong leadership, and these networks are where many leaders can be found.

  According to the evaluation data, leaders of NSTA state-affiliate organizations are an important group that is currently more skeptical about Project 2061 than some other key groups. Thus, it may be desirable to work with them in ways that maximize their perception of the usefulness of the products and ideas produced by the Project. (An example might be a workshop about use of the

curriculum analysis tools linked with a discussion of how that tool could best be used in states and districts.)

It may be possible to strengthen the ongoing work with existing networks, and perhaps extend it to other networks. Project 2061 might consider working regularly with a selected number of networks through mailings, e-mail, and face-to-face meetings. It might be worthwhile to devote a half-time staff position to such liaison work. For example, many professional associations have offices in Washington, DC, and Project 2061 might convene a meeting of leaders of these associations or networks on a regular basis, perhaps in conjunction with the National Research Council. Examples of professional associations are the National Association of Biology Teachers and the Physics Teachers Resource Agents project of the American Association of Physics Teachers. The Council of State Science Supervisors and the association of district science supervisors (now called the National Science Education Leadership Association) meet each year in conjunction with the annual meeting of the National Science Teachers Association, and a regular liaison with them might be planned at that time. Both of these groups play important roles in promoting reform. School principals are another important group.

Technological tools, such as e-mail systems or text-based multi-user immersive environments[12] (such as SRI International is now developing), can play especially useful roles in work with professional networks. Technology can supplement face-to-face meetings by providing extensive interaction with people in the network at relatively low cost.

- ***A district focus.*** District policy-makers can play key roles in promoting or impeding science education reform. However, with nearly 15,000 districts in the United States it is difficult to target this group. Special efforts might be made to work with a few large districts, especially urban ones, that face unique needs. Currently, the interview data suggest, there is some skepticism that national standards are applicable or achievable in those districts.
- ***Educational technology.*** The use of technology to improve teaching and learning is not a standard, per se, nor is it often identified as a separate component of systemic reform. Some leaders believe, however, that the kind of thoughtful, inquiry-based instruction being called for in science will not take place until microcomputer-based laboratories, graphing calculators, computer systems, and other technologically based tools are widely used in schools. Without them, the argument goes, teachers and students must spend too much time on mechanical features of inquiry, and not enough time will be spent on understanding concepts. (A very similar argument is used in mathematics, where the use of technology is becoming increasingly common, even at the undergraduate level. See, for example, Tucker and Leitzel, 1995.) Project 2061 might work to integrate technology more thoroughly into the vision of reformed

[12] The technology allows remote users access to sophisticated types of electronic "bulletin boards" and "chat rooms" to communicate and to create and share documents in flexible ways.

schooling in science education. Alliances with projects developing new technology tools for teachers and students, to be sure they are consistent with the science standards, could also be useful.

Reform at the undergraduate level. The majority of the users of Project 2061's products are in the schools or in state education agencies. Still, providers of undergraduate education, including preservice teacher preparation, are a critical audience for Project 2061, and some of the Project's earlier workshops have been specifically targeted to that audience. What undergraduate education initiatives might Project 2061 consider in the future?

- **Create a Benchmarks-like document for undergraduate education.** What should prospective teachers, or other college graduates, know about mathematics, science, and technology? Project 2061 might help define "science literacy" for these or for other, related contexts in the higher education system. Such an effort would complement the ongoing work in elementary and secondary education. Clearly, the higher education system exerts a large degree of influence on elementary and secondary students: by preparing their teachers, by setting requirements for college entrance, and in other ways. An initiative such as this one would build on past efforts, such as the creation of *Benchmarks* and the inclusion in *Resources for Science Literacy: Professional Development* of descriptions of 15 undergraduate college courses.

- **Work with the National Research Council.** Both the National Research Council and the National Science Foundation are engaged in a review of the strengths and weaknesses of undergraduate education. Project 2061 might find either or both of these organizations to be strategic partners in efforts to improve undergraduate education in science, mathematics, and technology.

These initiatives represent a broad array of important reform activities and are potential opportunities for Project 2061 to continue its instrumental role in shaping the national discourse about science education reform. They are consistent with the criteria elaborated above, but they are not the only initiatives that might meet these criteria or be appropriate activities for Project 2061.

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Evaluation of the American Association for the Advancement of Science's Project 2061

Volume I: Technical Report

Attachment A

METHODOLOGY

Attachment A
METHODOLOGY

In addressing the four research questions, the evaluation team engaged in five types of data collection:

- Expert interviews
- Telephone surveys
- Mail surveys
- Document reviews
- Case studies.

The methods for each of these activities are delineated below.

Expert Interviews

Several key audiences were included in the expert interviews: national policy-makers and national science education reformers, state policy-makers, commercial publishers and "alternative" curriculum developers, national and state professional association leaders, preservice teacher educators, district science supervisors and teachers, and education journalists.

The interviews sought information from the respondents regarding what they perceived to be the major trends in science education reform in the past few years, changes in major content ideas about science education, sources of the ideas and sources of influence on the reformers, and the role of Project 2061 documents and other national documents in the reform effort.

Telephone Surveys

Semi-structured telephone surveys were conducted with three target groups: state science supervisors, state curriculum framework writers, and state professional association leaders. In addition to questions specific to each target group, many questions were identical for all three groups; therefore, the survey questions provided uniformity of data across these three audiences.

The major sections of the telephone surveys were:

- Contextual background of the respondent, including main responsibilities and general sources of information on science education and reform.
- Perceived differences between and uses of *Benchmarks for Science Literacy*, the *National Science Education Standards*, and *The Content Core: Scope, Sequence, and Coordination*.

- Ratings of the influence of specific national and other documents on science education in the respondent's state.
- Specific contributions of Project 2061 documents in terms of their influence on the definition of science literacy and science education reform strategies in the respondent's state.

Analyses of these data then compared the respondents across groups, as well as examining their responses in the aggregate.

Mail Surveys

Three types of participants were identified as significant audiences to whom Project 2061 has targeted workshops: teachers, members of Project 2061's Leaders Network ("teacher leaders"), and teacher educators.

Limited information on participants constrained the ability to randomly sample teacher participants. Only those teachers for whom name and address information could be found were included in the survey. Virtually complete data existed for teacher leaders and educators who attended workshops from September 1994 through December 1995, and all these participants were mailed surveys.

All reasonable efforts were expended to maximize response rates, including:

- Sending reminder cards to nonrespondents 2 weeks after the initial mailout.
- Calling nonrespondents if the reminder card did not produce a response.
- Sending a second copy of the survey to nonrespondents in the event that the telephone call did not produce a response.

These efforts yielded the response rates shown in the table below.

	Survey		
	Teacher	**Leader**	**Educator**
No. of surveys sent	143	69	97
No. of surveys returned	91	43	55
Response rate	*63.6%*	*62.3%*	*56.7%*

The survey for each audience had four major sections:

- **Respondent's background.** This section asked for demographic data, including formal education, classes taught, years of experience.
- **Respondent's experience with workshops.** This formed a substantial portion of the survey and sought respondents' motivations for attending the workshops,

ratings of workshop benefits along specific dimensions, and ratings of agreement with specific Project 2061 ideas conveyed during the workshops.

- **Respondents' teaching practice.** This section identified major influences on what respondents teach and whether respondents' teaching practices along specific dimensions changed as a result of the workshops.
- **Conclusion.** Three open-ended questions asked about the use of *Benchmarks for Science Literacy*, the most useful aspect of the workshops, and suggestions for improving the workshops.

The survey for teacher leaders had an additional section that focused on respondents' training activities since the workshop.

Two analyses were performed with the data. Standard statistics and frequencies for each closed-ended question were analyzed and compared across audiences. The open-ended questions were coded and also provided much of the qualitative information to support the quantitative data.

Document Reviews

Document reviews consisted of three activities: staff review of curriculum frameworks to assess the appearance of alignment with Project 2061, expert review of curriculum frameworks to assess the fidelity of the frameworks to *Benchmarks for Science Literacy*, and expert review of selected textbooks to assess the fidelity of the textbooks to *Benchmarks for Science Literacy*.

Staff Review of Curriculum Frameworks

Forty-three states had appropriate curriculum frameworks, content standards, or some equivalent drafts or final documents. The other seven states were in the beginning stages of rewriting their state curriculum documents or were not engaged in writing any such documents.

These frameworks were reviewed for outward appearances of Project 2061 influences and specific ways in which the curriculum frameworks used references to Project 2061. Examples of references to Project 2061 were noted and coded according to the following categories:

- Listed as a resource for framework writers
- Contributed to the definition of science literacy
- Provided the rationale for change
- Recommended to the users of the framework as a resource
- Referred to in a summary of national reform efforts

- Used the outline of *Science for All Americans* or *Benchmarks for Science Literacy* as the organizational method of the framework.

Expert Review of Curriculum Frameworks

A group of 18 experts were convened to evaluate the quality of 12 selected math and science frameworks in a joint effort with two other projects: the U.S. Department of Education's Eisenhower State Curriculum Frameworks Project and the Council of Chief State School Officers' 50-state framework study supported by the National Science Foundation. The members of the expert group are listed below.

Experts Who Attended the February 1996 Meeting

Douglas Archbald, University of Delaware, Newark, DE
Rolf K. Blank, Council of Chief State School Officers, Washington, DC
Margaret Bondorew, Northeastern University, Boston, MA
Donald Chambers, University of Wisconsin-Madison, Madison, WI
Audrey Champagne, State University of New York at Albany, Albany, NY
Lynn Gatto, P.S. 39, Rochester, NY
Martha M. Green, Florida Department of Education, Tallahassee, FL
Susan Gross, Montgomery County Public Schools, Rockville, MD
Brenda Hammond, Page Elementary School, Silver Spring, MD
Andrea Keim, South Carolina Department of Education, Columbia, SC
Curtis McKnight, University of Oklahoma, Norman, OK
Celeste H. Pea, National Science Foundation, Arlington, VA
Harold Pratt, Biological Sciences Curriculum Studies, Lakewood, CO
Helen Quinn, Stanford Linear Accelerator Center, Stanford University, CA
Senta Raizen, The NETWORK, Inc., Washington, DC
Walter G. Secada, University of Wisconsin-Madison, Madison, WI
Larry Suter, National Science Foundation, Arlington, VA
Ruth Von Blum, Science Education Consultant, Los Angeles, CA

The experts were divided into four groups of approximately five people. Each group assessed the quality of three frameworks, following a guide that focused the reviewers on:

- Content of mathematics/science in the framework: In what ways does the framework adhere to and/or deviate from national standards?
- Pedagogy and presentation: What conceptions of teaching and learning does the framework present and what features are likely to help teachers make improvements in the classroom?
- Enabling conditions and policy linkages: Does the document make a clear linkage between its vision and the policy changes necessary to realize the vision, and does it address existing state curricular guides and the school, community, and family resources necessary for improving achievement in mathematics and science?

The experts made these assessments taking into account the specific state's political context, such as the existence of related state policies and documents, recent state politics, and the state's specific framework development process.

Expert Review of Textbooks

A number of the experts reviewing frameworks were also asked to review four textbooks for fidelity to *Benchmarks for Science Literacy*. Expert reviewers, in addition to SRI staff who facilitated the meeting, are listed below:

Expert Review Groups, Textbooks	
Elementary Texts	**Secondary Texts**
• Audrey Champagne, Science Education, SUNY-Albany • Lynn Gatto, Science Teacher • Ruth Von Blum, Science Education Consultant • Patrick Shields, SRI International • Lee Anderson, SRI International	• Martha Green, Curriculum Framework Specialist, Florida Department of Education • Celeste Pea, National Science Foundation • Harold Pratt, Biological Sciences Curriculum Studies • Helen Quinn, Stanford Linear Accelerator Center, Stanford University • Andrew Zucker, SRI International • Viki Young, SRI International

Experts conducted a two-phased analysis. The first, an overall textbook analysis, assessed how well the text is aligned with key Project 2061 tenets[13]; the second, a chapter

[13] A table showing "key tenets" of Project 2061 documents was developed for this evaluation, in consultation with Project 2061 staff.

analysis, assessed how well specific chapters matched *Benchmarks for Science Literacy* in both content and pedagogy. The latter analysis used a tool adapted from one that Project 2061 workshop presenters use to analyze curriculum materials (see exhibit below). Appropriate benchmarks were selected for each textbook, and reviewers evaluated how well the chapter addressed each benchmark.

Textbook Chapter Analysis

(Steps Adapted from Benchmarks for Science Literacy Workshop)

1. Become familiar with curriculum material (i.e., with chapter).
   - Consider together the body of the chapter, the margin notes in the teacher's guide, the lab activities, and any evaluative tools.
   - What are the stated themes?
   - What are the core concepts?
   - What is the level of vocabulary and amount of new vocabulary introduced?
   - What lab activities accompany the chapter?
   - What evaluative tools accompany the chapter?
2. Refresh your familiarity with the range of topics included in *SFAA/Benchmarks* and how they are organized.
3. Read the introductory essay and the list of benchmarks related to the chapter to be analyzed (enclosed). Add any other benchmarks to the list that you believe are relevant.
4. Read the relevant sections of Chapter 15, "The Research Base," in *Benchmarks for Science Literacy* (enclosed).
5. Read Chapter 13, "Principles of Effective Teaching and Learning," in *SFAA* (enclosed).
6. Analyze the likelihood that the chapter and its suggested activities will contribute to students' understanding the central benchmark(s)—the pedagogical match. The margin notes in the teacher's guide and descriptions of any laboratory activities and evaluation tools are likely most applicable here. A matrix for each chapter is attached with these questions, as is a column for your notes.
7. Analyze the match between the curriculum material and the content of the central benchmark(s). The central benchmarks are presented in a chart with questions to consider in evaluating how the chapter addresses the benchmarks.

Case Studies of Science Education Reform

To understand how Project 2061 is used in the context of a complicated education system, six case studies were completed. The states were chosen on the basis of their levels of activity in science education reform, and the mix of states reflects variation in

the locus of control. This diversity in case studies provided contrasting illustrations of how state and local contexts shape the influence of Project 2061.

Case Study Sample		
State	**Activities in Science Education Reform**	**Locus of Control**
Colorado	SSI; local standards development under way	Local control
Georgia	SSI; standards-based reform state; site of 2061 center	State control, although recently some local
New Jersey	SSI; Eisenhower curriculum framework grant	Local control tradition, but new state standards now emerging
New York	SSI; Eisenhower curriculum framework grant; active reform agenda	Mixed
South Carolina	SSI; draft standards and framework under review	State control
Wyoming	Professional development emphasis	Local control, no official standards or framework

Within each state, in-person interviews were conducted with individuals at each level of the education system, including state science supervisors, state curriculum writers, district science specialists, teachers, and professional development providers. These respondents were asked about their perceptions of Project 2061's influence in their respective roles, examples of that influence, how they currently use Project 2061, and, in some cases, their suggestions for future Project 2061 initiatives.

Data from these case study visits were organized in internal write-ups covering overviews of each state's political context and major education initiatives, specific science education initiatives, impacts of Project 2061 at the state level, and impacts of Project 2061 at the local level. These write-ups then formed an integral part of the analysis of the influences of Project 2061 at the state and local levels.

Evaluation of the American Association for the Advancement of Science's Project 2061

Volume II: Appendices

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CASE STUDY FINDINGS

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PROJECT 2061: COLORADO CASE STUDY

Education in Colorado

Colorado is a local-control state whose constitution outlaws mandating local curriculum, or even developing curriculum frameworks. However, traditional state quiescence in the education arena ceased with the election of Governor Roy Romer, a key participant in the development of the National Education Goals and an ardent supporter of standards-based reform.

Romer brought in legislation that established the Standards and Assessment Development and Implementation Council (SADI), whose first task was to develop model content standards in reading, writing, mathematics, science, history, and geography. The standards, which by law were supposed to be written with "consideration" of national content standards, are then to serve as the basis for an assessment instrument that would track student learning across the state.

By January 1997, districts will be required to adopt the state standards or to develop their own standards (in these same content areas) that meet or exceed the state standards. Moreover, the districts are then to align all curriculum, instruction, and assessment in the district with these standards.

Science (and Math) Education in Colorado

In Colorado, math and science do not hold the special position that they do at the national level. As in other content areas, math and science reforms are driven by the existence of the state content standards, the current drafting of performance levels, and plans for the statewide assessment—along with the state call for locals to follow this same strategy.

After a long process of public review and political compromise, the State Board of Education approved the math and science standards in May and June 1995. The standards-writing committees have moved on to drafting "performance levels" at grades 4, 8, and 11. These are more specific statements about what kids should know and be able to do at these three grade levels, which will be given to a test development company that will be awarded the contract to develop the state assessment. Meanwhile, the old state testing program was abandoned, so that no state-sponsored testing is currently under way in the state.

A Colorado SSI initiative, Project CONNECT, is funded at about $10 million over 5 years and supports 12 local partnerships made up of districts, institutions of higher education, and a business/community group. In receiving funds of up to $95,000 annually to support local standards-based reform, these partnerships are important because they provide districts with funds and outside expertise independent of the state and encourage K-12/IHE collaboration. The SSI is heavily involved at the state level, as well, and its leaders helped to staff the committees drafting the standards. In the grandest of visions,

the existence and support of the SSI in these 12 communities are meant not only to help those particular districts "do" standards-based reform well, but are also supposed to create models that could be followed by other districts across the state.

Impacts of Project 2061 at the State Level

At the state level, Colorado is a likely candidate to be influenced by Project 2061 because: (1) it has mandated standards-based reform and the development of state-level content standards; (2) its legislation specifically called for consideration of the national standards; (3) its timeline was such that the final version of the *NSES* had not yet been released; and (4) a number of key individuals in the state are personally connected to the national standards scene.

When the drafting committee (of 70 individuals) began their work in the 1994-95 school year, they had *Benchmarks* at the table as a key reference. The preface to the state standards says:

> These content standards were developed by a group of experienced Colorado science educators whose efforts have been guided—at least in part—by related work at the national level focused on defining what all students should know and be able to do in science. The *Benchmarks* from the American Association for the Advancement of Science's Project 2061 and draft reports from the National Science Education Standards Project at the National Research Council have been particularly useful and influential. (Colorado Science Standards, 1995: S-4)

Importantly, *Benchmarks* was not alone on the table. The group also had the California and New Jersey frameworks, as well as the most up-to-date drafts of the *NSES*. Very importantly, they had in the room a number of individuals closely involved in drafting the *NSES*. The group thus discussed many ideas, and *Benchmarks* was only one source.

The impact of *Benchmarks* was further limited by its size, comprehensiveness, and scholarly basis. Key drafters pointed to the usefulness of *Benchmarks* as an intellectual guide, but the committee did not feel obliged to deal with all of *Benchmarks* and certainly did not believe that they had to justify excluding something included in *Benchmarks*. In fact, many topics in *Benchmarks* are not included, such as the history of science, and science and society. Furthermore, the day-to-day criteria the committee used in drafting the standards were independent of national standards. That is, at first they asked what key ideas or main themes they wanted to cover (which they derived from *Benchmarks* and the *NSES*). Then they started to deal with the realities of their situation, which included:

- Restrictions on the number of standards—the state wanted this to be small and requested that all committees keep the number to six.
- Restrictions on specificity and pedagogy—for political reasons, it was important that these should be seen as model content standards, that they not tell teachers how to teach, and that there not be teaching standards.

- Contention over hot topics—evolution, the origin of the universe—was going to be a big issue.

Rather than debating the basic ideas, they were working to craft a politically acceptable document that could gain State Board approval.

The existence of content standards in the state has some potential for influencing state policy and actions as well as local policy and practice. If, for example, a new state test in line with the standards is developed and put in place, and test scores are highly publicized, the standards might end up having some reasonable influence. Because *Benchmarks* contributed to the ideas in the content standards, Project 2061 deserves some limited credit here. Tellingly, however, Project 2061 is in no position to provide the missing link in the Colorado reform effort: a reasonable professional development support system to help teachers put the new ideas into practice.

Impacts of Project 2061 at the Local Level

As at the state level, there is clear buy-in to the idea of standards-based reform at the local level (evidenced by a $1M commitment in a district, for example), so there is a great deal of potential for the standards to influence the educational system at the local level—depending on the degree of support and various political factors. However, there is little to no data on the degree to which state- and district-level policies have influenced schools or classrooms.

Has Project 2061 meant anything special at the local level? Or is its importance simply filtered through the state content standards? The latter is likely to be true in most small Colorado districts. The low-capacity districts will not be able to use *Benchmarks* or any other document to guide their reinterpretation of the state content standards. In the two suburban districts we visited, however, the standards-writing committees at least took out their *Benchmarks* and used it as a resource as they wrote. The high-capacity districts, like these, will revisit *Benchmarks*—but given all the competing demands, *Benchmarks'* impacts are likely to be minor.

Reflections on Project 2061

Colorado is a good example of the strengths and weaknesses of Project 2061. As a state committed to standards-based reform, Colorado has turned to *Benchmarks* and other national documents to guide its standards development. The result has been far from a one-to-one correspondence, but clearly *Benchmarks* has influenced standards development. However, all the other pieces that need to be put in place to actually change practice—from political alliances at the state level to local capacity building—are probably out of the sphere of influence of Project 2061.

Is there anything else that Project 2061 could do? Student assessment comes to mind. The local districts need to find alternative assessments, and the state wants to

contract out the development of a statewide assessment. There is a need for technical assistance or models at both the state and local levels in the area of assessment.

PROJECT 2061: GEORGIA CASE STUDY

Education in Georgia

Although Georgia has not traditionally been described as a strong local-control state, the local districts and schools have considerable control over education provided in their schools. Georgia is a textbook adoption state and has a Quality Core Curriculum (QCC) in a number of different content areas that districts use as guides for their district curriculum. The state has recently resisted the notion of standards-based framework development, although the QCC (originally developed during the 1987-88 school year) is scheduled to be revised during summer 1996.

The Georgia Department of Education (GDOE) has been through a number of restructuring efforts over the past few years, and its status/prominence has been called into question by the new, conservative State Superintendent of Schools. The Superintendent has created her own ad hoc committee, the "School Improvement Panel," made up of her own appointees, appointees of the Governor, and, more recently, of the State Board of Education. This panel has a QCC subcommittee that will oversee the long-term revision process. The assessment system is slated for revision after the QCC. The revision process will have a strong community component, since the public in Georgia is interested, organized, and definitely a factor in school and reform decision-making.

Science (and Math) Education in Georgia

The state's SSI began developing a reform-minded "Georgia Framework for Learning Mathematics and Science" during the 1991-92 school year. This *Learning Framework* specifies "habits of mind, the big ideas from science and mathematics, and the vehicles for understanding and doing," and is based primarily on *Benchmarks*. Despite much public support from the Georgia Council of Teachers of Mathematics, the Georgia Science Teachers Association, teachers, teacher educators, the State Board of Education, and the business community, the SSI project leaders anticipated potential backlash from both the State Superintendent (and her School Improvement Panel) and the public during the *Framework's* official spring '96 unveiling.

It is not clear how much (if at all) the *Learning Framework* will influence the QCC revision process. The *Learning Framework* was originally developed in response to general statewide disappointment with the QCC. The mathematics QCC does incorporate some conceptual development and problem-solving objectives, as recommended by the NCTM, but the science QCC is fragmented and tends to promote the acquisition of discrete facts.

Impacts of Project 2061 at the State Level

Project 2061's most significant impact at the state level has been on thinking about curriculum frameworks. Many of the key state education players are familiar with and use

Project 2061 materials. Most of these players (including GDOE staff) became very familiar with *Benchmarks* during the development of the *Learning Framework*. The *Framework* has been used in an attempt to change state policy, and has influenced a number of school districts throughout the state.

Project 2061's prospects for the future in Georgia are caught up in the volatile political situation (still to be decided) surrounding the QCC/*Learning Framework* debate. In general, Project 2061 and the SSI have had little impact on state-level assessment, which has a powerful influence in districts and which many change advocates view as a serious impediment to reform.

Impacts of Project 2061 at the Local Level

Project 2061's most significant impact at the local level has been on textbook adoption. The 7-year textbook adoption cycle focuses on science this year. The three districts we visited appeared to take the adoption process quite seriously, and they have been influenced by Project 2061 in a number of ways. Such influence varied from noticing which textbooks attempt to incorporate Project 2061 principles to actually rating the textbooks on how well they are in alignment with the *Benchmarks* themselves. It is clear that Project 2061 is playing a significant role in influencing which science textbooks will be in these district classrooms over the next 7 years.

With regard to instruction and curriculum at the local level, we met with teachers who had been influenced by Project 2061 ideas through their involvement either with the Project 2061 Center or with the SSI (but statewide this is probably a small minority of all teachers). The SSI focuses on improving middle-grade (4-8) mathematics and science education. It has a central organization and five regional centers that are all led by one or more institutions of higher education. Most of the centers collaborate with professional development schools in their region, and actively push the *Learning Framework* as the new standard for teaching and learning.

There is slight confusion among some local administrators and teachers over the existence of both the QCC and the *Learning Framework*. A few district administrators were hesitant to endorse or use the *Framework* ("we're not going to touch it yet") until it receives political acceptance at the state level.

Reflections on Project 2061

We found in Georgia that timing had much to do with whether people used or were familiar with the *Benchmarks* or the *NSES*. *Benchmarks* was extremely timely in Georgia with regard to both the *Learning* Framework development and the state's science textbook adoption cycle. A few people we spoke to actually mentioned timing specifically when talking about the delay in the *NSES* final draft.

Another factor that influenced people's reaction to the documents was the workshop or inservice they received on the different national science standards. One respondent said

that the *Benchmarks* training she attended was much more professionally done than the *NSES* training, which the SSI had helped sponsor.

Project 2061 may want to focus more energy on implementation strategies in its professional development efforts. Teachers can read and agree with the Project 2061 documents, but the hard part is actually making changes in the classroom. Some of the teachers we spoke with were looking for good examples of "Project 2061" lessons, and said that the "assumption that all teachers want to develop and personalize their own lessons" was false.

Most of the Project 2061 successes in Georgia were directly tied to the activity of the state's SSI. More attempts to link or work with the SSI projects in other states would probably increase Project 2061's influence.

PROJECT 2061: NEW JERSEY CASE STUDY

Education in New Jersey

New Jersey is a small, highly populated, economically and ethnically diverse state. Six hundred districts range from poor urban districts to affluent suburban districts, from large comprehensive districts to small single-school districts. New Jersey has a strong tradition as a local-control state; it is not a textbook adoption state.

The State Board approved new standards in seven content areas in May. A comprehensive plan links state funding for education to the content standards by using the standards as the definition of a "thorough" education.

The state department plans to launch a new 4th-grade assessment, as well as add science to the existing state assessments at 8th (Early Warning Test) and 11th (High School Proficiency Test) grades, with the intention of aligning all these assessments with the standards.

Science (and Math) Education in New Jersey

Whereas the mathematics curriculum framework is slated for completion by August 1996, the science curriculum framework development process has yet to begin. The department aims to complete a science curriculum framework within 1 year, although the mathematics framework committee required 3 years to do its work. Rapid deployment of the new 4th-grade assessment is driving the compressed science curriculum framework development schedule, but the state department plans to develop the assessments on a parallel track in any case. It is unlikely that the assessments and the framework will be deliberately aligned, regardless of how quickly the framework is produced.

New Jersey is an SSI state in its third year. In the first year, Thrust I operated professional development programs for school teams of teachers. Thrust II funded districts for districtwide systemic change. During its third year, the SSI is undergoing an internal reorganization, focusing on efforts with high longevity potential, and consolidating school, district, and professional development institution partnerships into clusters around the state. Until recently, the SSI has had difficulty gaining the attention of the state department. Now, however, the state department is recognizing the significance of the SSI effort and believes that the department could use the model the SSI created as the starting point for a much more systemic effort to build teacher capacity in support of the new standards.

Impacts of Project 2061 at the State Level

Informants consistently described Project 2061 documents as being influential behind the scenes, shaping the vision and the concepts in science education without being overtly recognized by name. The science standards committee used *Benchmarks* extensively in its

drafting of the standards, primarily to verify age appropriateness with respect to specific topics and to adjudicate content disputes.

SSI partner institutions also use *Benchmarks* in their professional development programs. The role of the document ranges from conveying the vision and goals of long-term science education reform, to defining for teachers appropriate content by grade clusters, to evaluating curricular units through a comparison with *Benchmarks*.

It is reasonable to anticipate that the science curriculum framework committee will also draw from *Benchmarks*, as well as the *NSES* and other national documents, since the chair of the standards committee, a vocal proponent of Project 2061, is likely to serve as the head of the framework committee as well.

Impacts of Project 2061 at the Local Level

The extent of Project 2061's influence at the district level in New Jersey is unclear. Although the Project 2061 Center in Philadelphia has been active in conducting workshops in New Jersey, their impact is not obvious. The ways in which *Benchmarks* is viewed and used at the district level vary tremendously.

In some instances, it was evident that Benchmarks is but one of many resources the district science supervisor had at her disposal for her own and her teachers' use. In other districts, the influence of *Benchmarks* is greater, where the district supervisor draws heavily from the document to write the district curriculum, uses it to inform her inservice topics, and cites it to lend credence to her arguments for reform.

Reflections on Project 2061

One of the most pressing concerns is a reconciliation between the *NSES* and *Benchmarks* documents that would address the confusion and the demand for one set of standards among teachers and administrators. The challenge for Project 2061 is to maintain the salience of its documents. With the current confusion, practitioners may gravitate toward the *NSES* because of its name and more recent publication and in an attempt to gain clarity about specific national standards. Project 2061 needs to define a process and product that can reconcile differences between the two documents and discuss their relative strengths and uses.

A second role for Project 2061 staff would be to review their documents for any necessary changes in content, advances in research, and thinking about the reform agenda, thereby making *Benchmarks* a more dynamic model.

Professional development providers and district science supervisors also requested an analytical tool that would apply *Benchmarks* to help in creating district curriculum.

Respondents did not think Project 2061 was an appropriate source for teacher professional development. Respondents believed that teacher professional development should be responsive to the needs of teachers, and thus requires an impartial approach and

an ability to draw on all relevant sources, including addressing and integrating the use of the *NSES*. Given the wide-scale undertaking that professional development constitutes, they felt that the staff and resources available at Project 2061 were inadequate for the effort. Project 2061's limited resources should be directed at efforts where its strength in content expertise and the prestige of AAAS can be maximally leveraged.

PROJECT 2061: NEW YORK CASE STUDY

Education in New York

Unlike in most states, all education in New York State—from prekindergarten through graduate and professional schools, and including libraries, museums, and other educational and cultural institutions—is under the jurisdiction of The University of the State of New York. Thus, the entire education system falls under the supervision of the State Board of Regents and their appointed executive officer, the President of The University and Commissioner of Education.

In New York, the State Education Department has had a long tradition of playing a strong role in shaping educational policy and practice. At the same time, the large number of districts allows for a good deal of local autonomy. Amid downsizing at the State Education Department; divisions between the Board of Regents, the state department, and the Governor's office; and charges that none of these institutions are held fully accountable for public education, the Chancellor and then the Regents said that there will no longer be two curriculums in New York. All students will be held to the higher academic standards of the Regents Curriculum and the (famous) Regents tests and diploma. The Regents-endorsed diploma is an indicator of rigorous effort and excellence. However, the state will be hard pressed to implement this initiative quickly, given the current unevenness in student achievement.

Although the state has been piloting New Standards and has made a few piloting efforts with other new forms of assessment, officials have not yet implemented any statewide reforms in the testing program. Recently, the state announced that the old reading assessments would be the sole source for a list of low-performing schools; thus, schools at risk of ending up on the state's list have placed more emphasis on teaching reading at the expense of other disciplines.

New York's vision for education is spelled out in the New Compact for Learning. The State Education Department is developing curriculum frameworks, including a recently completed Mathematics, Science, and Technology Framework.

Science (and Math) Education in New York

The first discipline-specific framework developed was the Math-Science-Technology (integrated MST) framework, overseen by the New York State Curriculum and Assessment Committee for Mathematics, Science, and Technology, a group that included teachers, teacher preparation faculty, business and industry representatives, government officials, scientists, and mathematicians.

In contrast to the writing process, the review process has been lengthy. Although the Regents approved the draft document for distribution and review in December 1993, the document was not revised until the summer of 1995. This time frame reflects the

department's view (perhaps in hindsight) that the main purpose of the curriculum framework in MST is to foster discussion with as wide an audience as possible. According to one Deputy Commissioner, "We wanted to bring in the whole village, not just professionals in the field. We produced a framework for discussion to focus on whether the standards were what [the professionals and the public] wanted."

Impacts of Project 2061 at the State Level

Project 2061 appears to have had an impact at the state level. Project 2061 and the *NSES* were both used in creating the MST framework—despite New York's tradition of "doing its own thing." Thus, New York's standards and framework reflect Project 2061, but are somewhat different. For example, the state made an attempt to more fully integrate mathematics, science, and technology than is done in *Benchmarks*. Perhaps inspired by *Science for All Americans* and *Benchmarks*, the framework defines technology as a discipline of equal importance to mathematics and science (not just a tool to learn mathematics and science). Few other states have adopted this approach.

Just how influential the framework will be in the state is an open question. On the one hand, it was developed with the full attention of the office responsible for other key pieces of the system, like assessment. On the other hand, districts may give the document limited attention. For example, New York City developed its own framework, and some district officials have dismissed the framework as too academic.

Project 2061 had a direct influence on the shape of the grade 4 science test. However, the current science skills test, although hands-on in nature, is not a measure of inquiry skills but rather of basic skills (such as using a thermometer). There is some movement to create alternative tests at the state level, which are being piloted around the state. These new assessments are expected to better reflect the framework and the national standards (even though they were piloted before the framework was approved).

Because the state context is so strong, there is little perceived need for districts, schools, or teachers to "look outward" to national norms. Thus, some district specialists may know about the AAAS, NCTM, or NRC standards, but they pay more attention to the state frameworks and assessments. Ironically, then, rather than serving as a conduit for getting the national documents down to the districts, the state frameworks and assessments may tend to keep the local levels from getting to them.

Impacts of Project 2061 at the Local Level

Districts have strong autonomy and tend to do things very differently from one another. They create a district scope and sequence, which is usually the only document teachers use in their work. Teachers see little of the state standards or frameworks and very little of the national documents. Thus, national documents tend to be fairly remote voices in New York, and perhaps have been most helpful in providing political backing to those already pursuing inquiry and other reform approaches. The national documents tend to come into districts through district science and math curriculum specialists, but these

staff vary greatly in the degree to which they are connected to the national scene. In terms of equity, it appears that the poor, small, urban districts (e.g., Troy) have little access to reform documents or thinking. By contrast, the SSI has helped connect larger districts to national reforms.

Teachers do not appear to be engaged extensively in professional development in math, science, and technology. When they are, their experience tends to be traditional and focused on units that help them meet the requirements of state tests. Professional development also seems focused on generic reforms (cooperative learning, conflict resolution) rather than on discipline-specific reforms.

At the high school level, the Regents exam has a strong influence on teachers of the 4 out of 10 students who receive a Regents diploma. Other strong influences on instruction tend to be those closest to the teachers: their department, their school, and their district. From what we have seen, teachers have little direct access to *Benchmarks* or the *NSES*.

Reflections on Project 2061

New York is an example of a state where Project 2061 has had some influence on the major state-level science education reform efforts. For example, Project 2061 documents have been one of many influences on the content of the mathematics, science, and technology curriculum framework, and have informed some existing assessments, as well as those currently being piloted. At the local level, teachers are more likely to be influenced by district curricular guidance, school curricular guidance, state tests, and state frameworks than by national standards documents. Although state and local curricular guidance and assessment tend to overshadow documents like *Science for All Americans* and *Benchmarks*, most of those state and local products seem to adhere to many of the key tenets of Project 2061. New York and Project 2061 might benefit from a careful analysis of the alignment with Project 2061's key tenets of the emerging new assessments, the new MST framework, and a sample of local curriculum guides.

PROJECT 2061: SOUTH CAROLINA CASE STUDY

Education in South Carolina

The state is the locus of control for education in South Carolina, and assessments have been the driving force for reform. In the past 6 years, a strong State Department of Education, under the leadership of Dr. Barbara Stock Nielsen, has been attempting to improve South Carolina's education system. Driven by economic considerations (to attract and maintain new industries, the state is committed to increasing the technological capacity of its workforce), the state has moved forward with a vision around the following formula: high academic standards + adequate resources + local control + accountability = success for ALL students.

The state is moving away from a "basic skills" approach, which has left South Carolina's students near the bottom of national norm-referenced tests, toward new curriculum frameworks and assessments that emphasize higher standards. Over the past 3 years, the state has released new frameworks in Visual and Performing Arts, Foreign Languages, and Mathematics, and has created draft frameworks in English/Language Arts, Science, Health/Safety, Social Studies, and Physical Education.

South Carolina has statewide textbook adoption, with elementary mathematics texts in place this year adopted in alignment with the new mathematics framework. Science textbooks were chosen for adoption this year, and materials will be in place next year. The adoption process involves a state committee that prepares a list of books/series that are closely tied to the frameworks. Districts then review the list of books, get samples, try them out, and make a districtwide selection from the state list.

In other developments at the state level, education regulations are being reviewed and "rolled back" in an attempt to encourage local control. Moreover, the system of funding education in the state, which has led to great disparities in funding from district to district, is also under review. Although bold accountability legislation with assistance and then severe consequences for low-performing schools was tabled this year, current policies can still penalize low-achieving schools. The net result is that education in the state is somewhat schizophrenic at the moment: districts and teachers are expected to work from the new frameworks, but incentive pay, rewards, and punishments for their work are still being driven by the old basic skills assessments.

Science (and Math) Education in South Carolina

Science and mathematics reforms in South Carolina are in their infancy. The mathematics framework was adopted in November 1993. The science framework has been drafted and is currently in a public review phase, with approval pending in fall 1996. Achievement standards based on the math and science frameworks have also been drafted and are being reviewed; new assessments that are aligned with the frameworks are being or will be created to replace the Basic Skills Assessment Program.

Technology is also central in current reform efforts in South Carolina. A $600-million technology plan details a vision for technology in schools in South Carolina; the state has committed $20 million to this plan. While we were conducting our site visits, the Governor announced "education license plates"—the money from these will go to purchase computers. The push thus far appears to be tied more to hardware than to software or curriculum.

South Carolina has a strong SSI composed of 13 regional hubs that work closely with the State Department of Education in moving reforms in science and math forward. However, partly because of the infancy of the reforms and the disparities in funding for education from county to county, significant reforms in science and mathematics education are found only in "pockets" throughout the state.

Impacts of Project 2061 at the State Level

The format of the state science framework closely follows the format of the *National Science Education* Standards. The main difference is that the South Carolina science framework—in particular, the content part—focuses more on specific skills and competencies. The science framework is organized into three domains: the nature of science, process skills, and knowledge of science. The framework also breaks up grade levels differently from the *NSES*, but the overall structure of the document is the same, including sections on assessment, professional development, and considerations of the whole system.

Project 2061 materials were used as a reference in writing the framework, but not explicitly drawn on in the actual development of that framework. State department staff did note that they read versions of the *Benchmarks*, but the direct influence of these documents is clearly less than the *NSES'* influence. The state's mathematics framework is closely aligned with the NCTM standards. The state clearly wants its framework documents to be the key documents in the state. The national-level documents are used mainly when appropriate for lending legitimacy—they are "waved around at meetings or formal presentations to show people that 'it isn't just me saying this.'"

As yet, we do not know the influence these national-level documents will have on the new assessments, but conversations with those in decision-making positions indicate that there will be strong links. The continued development of the reforms rests largely on what happens with the assessments.

Impacts of Project 2061 at the Local Level

The influence of the national-level documents on the local level has been indirect. The national documents exert a strong, although indirect, influence on the local frameworks in science and a more direct influence on the local level in math. Districts have begun creating new districtwide curricula based on the state frameworks (which, in turn, have been strongly affected by the national documents).

The districts visited were in the process of taking the state frameworks and adapting them to meet the needs of their districts. Each district wants its curriculum guides to be "the document" within the district. As one district director of curriculum and instruction said, "Teachers have made them [state frameworks] their own. Until you take them apart and put them together, they are no one's standards." Some district personnel, teachers and administrators said they "knew of" the national documents, but they primarily referred to the document generated at the level directly above them (districts refer to the state frameworks; teachers refer to the district curriculum or framework). Also, reform materials tended to focus more on specific skills and somewhat less on philosophy the closer they got to the district level. In some cases, we saw reforms being interpreted in fairly traditional ways, with content being the area of primary focus.

In a few of the districts, other factors (such as funding levels, assessments, quality of administrators, facilities, expectations of student skills and knowledge from the level above, availability of technology, access to and emphasis placed on professional development at the district level) tend to have a more immediate and direct influence on science and mathematics at the local level than do the national documents.

Reflections on Project 2061

The national documents have had the most influence at the state level in South Carolina, with Project 2061 on the whole having less impact than the *NSES*. *Benchmarks* appears to be a more difficult document from which to build a state framework, and thus, its influence in South Carolina is less direct. The undergraduate level and assessments are key areas that will need to be successfully addressed for reforms in South Carolina to take hold. Perhaps the best new role for Project 2061 may be to define the knowledge all students should know at the end of their undergraduate education.

PROJECT 2061: WYOMING CASE STUDY

Education in Wyoming

Control resides at the local level in Wyoming. For decades, individual districts, schools, and teachers have determined what and how to teach. The State Department of Education's only requirements in the past have been that districts have a curriculum and have documentation that this curriculum is being implemented.

However, this situation is changing in light of a recent Wyoming Supreme Court ruling that charged the legislature to determine what the whole system of education in Wyoming should be doing: what students should know, how student knowledge should be assessed, and how education should be funded in the state. The legislature is just beginning work on this "basket of education," and the net result may well be an increased state role in the future.

Science (and Math) Education in Wyoming

There are no state tests in science and math in Wyoming, nor is there statewide textbook adoption. Science and math are highly intertwined, in part because the former state-level coordinator covered both science and math and in part because there are so few teachers in the state.

Professional development has been the main emphasis in science and math education in recent years through the strategic use of very ample Eisenhower funds. Because of the relatively small number of teachers in the state (average student/teacher ratio of 15:1) and the generous minimum amount allocated by law to low-population states, Eisenhower funds go a long way. These funds have been the key influence in the state, fueled in the past by the efforts of a strong coordinator of science and math at the state level and close working relationships between this coordinator, the faculty from the University of Wyoming Center for Math and Science, and the Wyoming Council of Teachers of Mathematics (WCTM) and Wyoming Science Teachers Association (WSTA). These three centers of state-level activity have worked closely together in the past, creating a close-knit community of science and math teachers.

Also, the state has "strictly" implemented the Eisenhower funds, using them solely for professional development and not for the purchase of materials. These funds have supported teachers' participation in local, regional, and national conferences (NSTA and NCTM, in particular). The funds have brought in national-level individuals in science and math to conduct workshops throughout Wyoming, and increased teachers' participation in science and math programs at universities across the country.

Impacts of Project 2061 at the State Level

Ideas and language present in the *Benchmarks* and the NCTM standards were widely held by state-level people we interviewed as the "vision" for math and science in the state, although (or perhaps because) there is no "official" state document. The professional organizations (WCTM and WSTA) are influenced by national trends and provide teachers with direct access to national reform documents. The documents may maintain more of their integrity when they are passed along in this fashion as opposed to being "filtered" through state- and district-level curriculum guides.

College of Education faculty at the University of Wyoming require the reading of *Benchmarks* and NCTM *Standards* in their preservice education courses, and indicated that they will do the same with the *NSES*. However, we saw little evidence that these documents have had any influence on teaching at the university level outside the College of Education.

Impacts of Project 2061 at the Local Level

Because the emphasis in the state is on local control, what gets taught tends to be influenced most strongly by teacher-to-teacher interactions. Reforms tend to happen in "pockets of excellence" throughout the state.

At the local level (and, to some extent, at the state level), there was a lack of clarity about the distinction between *Benchmarks* and the *NSES*. (People often referred to the "standards" when their description of the document indicated that they meant *Benchmarks*.) District-level personnel said they were familiar with *Benchmarks* and that they "referred to them" in developing district-level curricula. However, we saw little direct influence of *Benchmarks* at this level, either in our conversations with district-level personnel or in the documents they had created.

The *NSES* has had almost no direct or traceable influence to date in Wyoming at a district, school, or teacher level—the standards are too new. However, the WSTA sponsored a series of workshops in spring 1996 on the *NSES*. In contrast, the NCTM standards were well known and used at every level.

As mentioned before, the influence of the national documents on the teacher level comes primarily through teachers' association with state and national professional organizations and professional development experiences. Although direct translations of the reform documents were rare, key messages or "notions" from *Benchmarks*, the *NSES*, and the NCTM standards were present in conversations with almost all the teachers we interviewed about their vision for science and math education. Key phrases we heard included science and math for all children, real-life applications, problem-solving, the importance of technology, the integration of math and science, alternative assessments, and a focus on the process of science. In this sense, the "notions" of the documents preceded the actual documents.

In addition to the influences mentioned above, high school teachers tend to be influenced by college entrance requirements, SAT/ACT tests, and textbooks. Middle and elementary school teachers tend to be influenced by the next grade level's expectations of their students and by available materials and texts.

Reflections on Project 2061

Eisenhower funds, the small number of teachers in the state, and the strong influence of the former math and science coordinator in Wyoming have helped create a statewide vision of math and science teaching; however, because of the lack of a coordinator's guidance in recent years, that vision is not as widely shared as it potentially could be. Thus far, the path of the implementation of reforms in other states—national document to state department-generated state frameworks to district curricula to teachers—has not been followed in Wyoming. Rather, reforms have relied on professional and personal networks, moving directly from the national level to the teachers (via professional organizations and professional development) and then from the teachers to the districts.

The professional organizations are very influential in Wyoming, and they promote the national reform documents. There needs to be more clarity about the two existing national science documents (*Benchmarks* and the *NSES*); teachers we interviewed wondered why there were two documents and felt that, if there were two documents, clearly the messages in them were different.

Appendix B

FINDINGS FROM AN ASSESSMENT OF THE QUALITY OF TEXTBOOKS

Appendix B
FINDINGS FROM AN ASSESSMENT OF THE QUALITY OF TEXTBOOKS

In February 1996, a distinguished group of science education experts gathered to review chapters of four recently published textbooks: two elementary science textbooks and two secondary biology textbooks (see Appendix A). In preliminary interviews, publishers suggested that Project 2061 and *Benchmarks for Science Literacy* were recent influences on textbook development. The reviewers were asked to determine the ways in which these new textbooks reflect, or fail to reflect, the principles of Project 2061.

Textbooks Reviewed

Specific chapters and sections reviewed for each textbook are outlined below:

1. *Discovery Works* (Teacher's Guide/Grade 5), Silver Burdett Ginn, 1996
   - Chapter 2, "The Solar System," pp. B28a-B52b, including: margin notes for teachers; science, technology, society discussions; historical episodes of science notes; laboratory investigations
   - "About the Program," pp. T3-T24
   - "Science Handbook" section, pp. T25-T42

2. *Discover the Wonder* (Teacher's Edition), Scott Foresman, 1994
   - Module A, Chapter 2, "The Solar System," pp. A23a-A41, including: margin notes for teachers; science, technology, society discussions; historical episodes of science notes; laboratory investigations
   - Introductory section, pp. FM1-FM16
   - "Experiment Skills" section, pp. 1-27 (back of book)

3. *Biology* (Annotated Teacher's Edition), Miller & Levine, Prentice-Hall, 1995
   - Chapter 13, "Evolution: Evidence of Change," and Chapter 14, "Evolution: How Change Occurs," pp. 268-317, including: margin notes for teachers; science, technology, society discussions; historical episodes of science notes; laboratory investigations
   - "Teacher's Guide," pp. T4-T33
   - "For Further Reading" reference section, pp. Reference 1-6

4. *Biology Principles and Explorations* (Annotated Teacher's Edition), Johnson & Raven, Holt, Rinehart, Winston, 1996
   - Chapter 12, "Theory of Evolution," and Chapter 14, "Human Evolution," pp. 244-271 and 294-313, including: margin notes for teachers; science, technology, society discussions; historical episodes of science notes; laboratory investigations
   - Introductory section, pp. 18T-59T

Summaries of Expert Reviews of Textbooks

The following provides summaries of the expert reviews of the elementary science and secondary biology textbooks.

Elementary Science Textbooks: Findings

In all chapters, there are numerous concepts that are too advanced and too abstract for 4th- and 5th-grade students, according to the reviewers' reading of Chapter 15 of *Benchmarks for Science Literacy*. For example, some suggested activities include discussions of the big bang theory and a focus on the scale of the universe, both of which the Research Chapter in *Benchmarks* indicates would be too advanced for students at this age. Compounding this problem is the absence of suggestions for dealing with student misconceptions about science as catalogued on p. 335 of *Benchmarks*.

Many of the reform ideas that are consistent with *Benchmarks*, to the varying degrees that they occur in these texts, are much more prominent in the teacher's guides than in the student texts. This approach relies on the teacher to emphasize these issues in his or her teaching.

There are suggestions for cooperative learning and grouping, and more interdisciplinary links than in the average texts of 15 years ago. Hence there is evidence of new ideas in the texts reviewed, especially in the teacher's guides.

In both texts, experimentation is not inquiry based. Students are given exact procedures for experiments and answers to be confirmed. Students do not get to design their own investigations (admittedly difficult with the solar system, but possible through night sky observation, for example).

In *Discover the Wonder*, experimental skills are relegated to a separate chapter at the end of the book, which strongly suggests that it was merely added to an earlier edition. Experimental skills are not integrated into earlier chapters and receive limited treatment in the teacher's guide.

Discovery Works makes explicit claims about its relationship to *Benchmarks*. It over-analyzes this relationship in the teacher's introduction by presenting numerous matrices and lists. This strategy led to some counterintuitive decisions by the authors, like separating critical thinking and scientific reasoning skills. However, the right ideas are on

the lists and tables. It would have been more helpful to integrate these layers and lists with the rest of the teacher's guide.

Secondary Biology Textbooks: Findings

The reviewers generally felt that although the textbooks seem to move toward the vision of science literacy espoused by Project 2061 and the *National Science Education Standards*, there is much room for improvement.

The teacher's guides provide some useful suggestions about different aspects of science literacy, such as elaborations on science history and strategies for incorporating multicultural issues, LEP students, and science, technology, and society linkages. However, many of these notes appear only in the teacher's guides, not the student texts, thereby making it quite easy for the teacher to skip them and for the student to lose exposure to these enhancements. Furthermore, the group felt that although these notes covered the "correct" topics, many examples were superficial.

The group provided positive feedback on a number of different dimensions. Both books are very readable for high school students. The reviewers felt that the reading level is geared appropriately for the average high school student and that the presentation of the books is appealing. The group also felt that, with some effective inservice instruction, the teacher's guide might be very useful to novice or returning teachers. Although the marginal notes might be superficial, they are suggestions and catalysts for thinking about issues that novice and returning teachers might not otherwise consider.

The group was impressed by the efforts to draw linkages to geology, particularly in the Miller and Levine text. That text attempts to make connections to earth science through the introduction of fossil evidence. The Johnson and Raven text, on the other hand, does not draw as strong linkages to earth science. Although fossil evidence is presented, it is not presented as evidence of evolution—rather, fossil evidence is presented as geological fact.

The group also felt that the authors missed other opportunities for linkages. For example, the mathematics behind calculating half-life is omitted from the discussion of half-life testing. The linkages to social science could have been further developed through the story of Darwin. One textbook describes Darwin's role as the captain's companion because the captain was not allowed to socialize with the crew. It also mentions Darwin's parents' desire for him to become a minister. The reviewers thought that these issues of class, family, and religion could have been used to engage the students by using the information as "hooks" to draw students in and create a comfort level for discussing evolution with the class.

There are several areas where the textbooks perform less satisfactorily. Both books note the importance of science literacy but do not attempt to define it. Presumably, the topics covered in the textbooks comprise a portion of science literacy.

The chapters on evolution that the reviewers examined do not adhere to the "less is more" philosophy. The group found unnecessary terminology strewn throughout—e.g., "industrial melanism"—which ultimately obfuscates the major concepts. The glossaries in these books each contain about a thousand technical terms. Both books are massive.

None of the chapters clearly explain or demonstrate that the concept of variation within species, which is then subject to natural selection, is the crucial concept of evolution. This concept is presented with the same amount of emphasis as that allotted to all other topics, such as the relationship between Malthus and Darwin's theory. The reviewers felt that the range and type of topics covered are essentially the same as those covered 12 years ago.

The organization of the chapters does not follow the nature of science and is not predicated on sound science pedagogy, in the opinion of the group. Inquiry-based teaching and the scientific method both suggest the exploration of evidence first, from which conclusions are then drawn. The textbooks, while presenting much of the available evidence on evolution, nonetheless present the theory first as a statement of fact, rather than allowing the student to draw conclusions based on the evidence presented. The evidence is available but is not marshaled in a compelling fashion that is consistent with the nature of science and good science pedagogy.

The marginal notes and the teacher resource sections make reference to many aspects of pedagogy that reflect Project 2061 notions. However, when the reviewers delved deeply into the text, it was apparent that there was inconsistency between the espoused views and the actual activities supported by the text. For example, the actual assessments are recall based, and the lab activities are not inquiry based. Teachers are advised to ask students to write down their ideas of evolution before and after the unit, but there are no follow-up activities suggesting how the teacher could use these writings.

Appendix C

LIST OF CURRICULUM FRAMEWORKS EXAMINED FOR THE EVALUATION OF PROJECT 2061

Appendix C

LIST OF CURRICULUM FRAMEWORKS EXAMINED FOR THE EVALUATION OF PROJECT 2061

Evaluation staff reviewed 43 state curriculum frameworks or standards documents to assess the appearance of alignment with Project 2061 documents. In addition, the expert review group examined in greater detail six science and two integrated math and science curriculum frameworks to evaluate their quality in terms of fidelity to *Benchmarks for Science Literacy*. The state documents that were reviewed by staff are listed below, along with an indication of those that the expert group also reviewed.

State	Name of Document	Expert Review
Alabama	Alabama Course of Study, Science, 1995	
Alaska	Alaska Mathematics and Science Framework, March 1995	√
Arizona	Arizona Science Essential Skills, June 1990	
Arkansas	Arkansas Science Curriculum Framework, 1995	√
California	Science Framework for California Public Schools, Kindergarten through Grade Twelve, 1990	
Colorado	Colorado Model Content Standards for Science, 1995	
Connecticut	A Guide to Curriculum Development: Science, 1991	
Delaware	New Directions, Delaware First In Education, Science Curriculum Framework, Content Standards, June 1995	√
Florida	Science for All Students, The Florida Pre K-12 Science Curriculum Framework, 1993	
Hawaii	Hawaii State Commission on Performance Standards, June 1994	
Idaho	Idaho K-12 Science Content Guide and Framework, 1994	
Indiana	Key Elements of the Science Proficiency Guide, 1993	
Iowa	A Guide to Curriculum Development in Science, 1991	
Kansas	Curricular Standards for Science, 1995	
Kentucky	Transformations: Kentucky's Curriculum Framework, 1995	
Louisiana	The Louisiana Science Framework, 1995	√
Maine	Maine's Curriculum Framework for Mathematics and Science, 1995	√
Maryland	High School Assessment, Science Core Learning Goals, 1995	
Massachusetts	Massachusetts Curriculum Frameworks for Science and Technology, 1994	
Michigan	Benchmarks for the Michigan Model Content Standards for Curriculum, 1995	√
Mississippi	Mississippi Science Framework, 1990	
Montana	Tool Kit for Science Curriculum Development	

Nebraska	Mathematics and Science Frameworks for Nebraska Schools, Kindergarten through Grade Twelve, 1994	
Nevada	Science, 1994	
New Hampshire	K-12 Science Curriculum Framework, 1995	
New Jersey	New Jersey Science Content Standards, 1995	
New Mexico	New Mexico Science Framework, 1992	
New York	Curriculum, Instruction, and Assessment Framework for Mathematics, Science, and Technology, 1993	
North Carolina	North Carolina Competency-Based Curriculum Science, 1994	
North Dakota	North Dakota Curriculum Frameworks, Volume I, 1993	
Ohio	Ohio's Model Competency-Based Program, 1994	
Oklahoma	Priority Academic Student Skills, A Core Curriculum for Our Children's Future, Science, 1993	
Oregon*	Oregon Mathematics and Science Curriculum Framework on CD-ROM	√
Pennsylvania	Science and Technology, Curriculum Framework for Pennsylvania, 1995	
Rhode Island	Science Framework for Rhode Island, 1995	√
South Carolina	South Carolina Science Framework, October 1995	
Tennessee	Science Framework, Grades Kindergarten through Grade Twelve	
Texas	Science Essential Knowledge and Skills Development, 1995	
Utah	Science Core Curriculum, Grades K-6, 1994; Science Core Curriculum, Grades 7-12, 1995	
Vermont	Content Standards for Vermont's Common Core Framework for Curriculum and Assessment, 1995	
Virginia	Science Standards of Learning for Virginia Public Schools, 1995	
Washington	Essential Learning Academic Learning Requirements, 1995	
Wisconsin	Changing Perspectives: Wisconsin Frameworks in Science and Mathematics, draft 1995	
Wyoming	A Vision for Science Education in Wyoming	

* Oregon Mathematics and Science Curriculum Framework on CD-ROM was included only in the expert review, not the staff review.

Appendix D

MAIL SURVEYS FOR PROJECT 2061 WORKSHOP PARTICIPANTS

Teacher	35
Teacher Leader	49
Teacher Educator	65

SURVEY OF PROJECT 2061-SPONSORED *BENCHMARKS FOR SCIENCE LITERACY* WORKSHOP

EVALUATION OF PROJECT 2061 (AAAS)

QUESTIONS? PLEASE CALL:

Viki Young (415) 859-2751

Please use the enclosed envelope to return the completed questionnaire to:

Evaluation of Project 2061 (AAAS)
SRI International
BS-181
333 Ravenswood Avenue
Menlo Park, CA 94025

Please take a moment to read this important information before you begin the questionnaire.

This survey is being conducted for the American Association for the Advancement of Science (AAAS), as part of a larger effort to evaluate the impact of AAAS' Project 2061. This is a short survey and will take only a few minutes to complete. Project 2061 is committed to long-term science education reform, and an integral component of its reform strategy is the ***Benchmarks for Science Literacy*** **(Project 2061) workshop** you attended. Your feedback on the workshop will be extremely valuable in Project 2061's continuing efforts to support science education reform.

Your responses will be **completely confidential**. Your answers to this survey will be aggregated with those of all respondents and summarized for AAAS.

We appreciate your taking the time to complete this short survey, and thank you in advance for your cooperation.

Directions

- Please read all questions and instructions carefully. Answer the questions by circling the appropriate number or writing in the answer, if requested to do so. It is important that you limit your response to one alternative for questions that direct you to "Circle One." We cannot use your answer if it is between two responses or if you change the wording of the question in any way. Please pay careful attention to the labels on scales in questions where you are asked for a rating. *Benchmarks for Science Literacy* is also referred to as *Benchmarks*.

- When you have finished the questionnaire, please return it to **SRI International** in the enclosed self-addressed, stamped envelope.

- Please return this survey by **Monday, February 12, 1996**.

- If you have any questions, please contact Viki Young at SRI International, (415) 859-2751.

Section A. Your Background

1. Which statement best describes your formal teaching responsibilities? *(CIRCLE ONE)*

I currently teach classes at a school (K-12 level).....	1
I conduct inservice sessions for my school or district.....	2
I am a post-secondary instructor.....	3
Other (please specify) _____	4

2. Please list the class(es) you teach and their associated grade level(s) or the inservice session(s) that you conduct.

	Class/ Inservice session	**Grade level**
a.	_____	_____
b.	_____	_____
c.	_____	_____
d.	_____	_____
e.	_____	_____
f.	_____	_____

3. Please estimate the percentage of students you teach who **receive free or reduced lunch**. Circle "na" if you conduct inservice and do not teach students. *(CIRCLE ONE)*

0% to 9%.....	1
10% to 19%.....	2
20% to 29%.....	3
30% to 39%.....	4
40% to 49%.....	5
50% to 74%.....	6
over 75%.....	7
na.....	8

4. **Please estimate the percentage of students in your school who are in the following categories.** ***(TOTAL SHOULD ADD TO 100%)***

White	_____%
African American	_____%
Latino/a	_____%
Asian or Pacific Islander	_____%
American Indian or Alaskan Native	_____%
Other	_____%
Total	**100%**

5. How many full-time equivalent (FTE) years have you been teaching? Count each full-time year as 1 year and each part-time year as the appropriate fraction of 1 year for your total experience (e.g., if you taught 2 years at full-time and 1 year at half-time, your total experience would be 2.5 FTE years.) Exclude any breaks in service.

   Number of FTE years: _____

6. How many full-time equivalent (FTE) years have you been teaching **science**? Exclude any breaks in service.

   Number of FTE years teaching **science**: _____

7. Which of the following degrees do you hold? *(CIRCLE ALL THAT APPLY)*

Degree	Major	
a. Bachelor's	Science	1
	Science Education	2
	Mathematics	3
	Math Education	4
	Other	5
b. Master's	Science	6
	Science Education	7
	Mathematics	8
	Math Education	9
	Other	10
c. Ph.D.	Science	11
	Science Education	12
	Mathematics	13
	Math Education	14
	Other	15
d. Other (please specify)		
_____		16

8. A. Please circle the number that corresponds to the total amount of time, within the **last 12 months,** that you have spent on inservice in **science or the teaching of science**. Do not include formal courses for which you received college or continuing education credit.

B. Then circle the number that corresponds to the total amount of time you have spent on inservice for these topics in the **last 3 years**, including the last 12 months. *(CIRCLE ONE NUMBER IN EACH CATEGORY)*

Hours of inservice in science or science education	A Last 12 months	B Last 3 years
None	1	1
Less than 6 hours	2	2
6 - 15 hours	3	3
16 - 35 hours	4	4
More than 35 hours	5	5

Section B. Your Experience with *Benchmarks for Science Literacy* (Project 2061) Workshops

9. When did you most recently attend a Project 2061-sponsored *Benchmarks* workshop? *(CIRCLE ONE)*

November 1994	1
December 1994	2
March 1995	3
June 1995	4
July 1995	5
October 1995	6
Other (please specify) _____	7

The following questions refer to your **most recent** *Benchmarks for Science Literacy* workshop.

10. Approximately how many hours did the workshop last? *(CIRCLE ONE)*

Less than 2 hours	1
2 - 6 hours	2
One day	3
More than one day	4

11. Please indicate your most important reason for attending this *Benchmarks* workshop. *(CIRCLE ONE)*

Scheduled as part of a regular inservice session	1
Wanted to enhance my science teaching skills	2
Particularly interested in learning about Project 2061 and *Benchmarks for Science Literacy*	3
Involved in curriculum development for school or district	4
Other (please specify) _____	5

12. Please rate each of the following potential outcomes of the workshop in terms of its benefit to your work, using a scale of 1 to 5, where 1 represents no benefit and 5 major benefit. *(CIRCLE ONE NUMBER FOR EACH LINE)*

	No benefit	Little benefit	Some benefit	Significant benefit	Major benefit
a. **Increased familiarity with Project 2061 reform and science literacy concepts**	**1**	**2**	**3**	**4**	**5**
b. Developed skills in using *Benchmarks for Science Literacy* to analyze curriculum materials	1	2	3	4	5
c. **Gained confidence in analyzing curriculum materials**	**1**	**2**	**3**	**4**	**5**
d. Acquired new ideas and methods for implementing inquiry-based lessons	1	2	3	4	5
e. **Gained appreciation for working with teachers across multiple grade levels**	**1**	**2**	**3**	**4**	**5**
f. Increased science knowledge	1	2	3	4	5
g. **Discovered resources for augmenting science knowledge**	**1**	**2**	**3**	**4**	**5**
h. Other (please specify and circle) _____	1	2	3	4	5

13. Overall, how beneficial was the workshop to your work? *(CIRCLE ONE)*

No benefit	Little benefit	Some benefit	Significant benefit	Major benefit
1	2	3	4	5

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14. A. The *Benchmarks* workshop that you attended attempted to convey certain ideas about science education. Were the following ideas conveyed clearly and explicitly during the workshop?

B. To what extent do you agree or disagree with each idea?

(CIRCLE ONE NUMBER IN COLUMN A AND ONE NUMBER IN COLUMN B FOR EACH LINE)

	A Idea conveyed clearly and explicitly			B Agreement with idea				
	Yes	Some-what	No	Disagree strongly	Disagree somewhat	Neu-tral	Agree somewhat	Agree strongly
a. Changes in the education system should be driven by important, specific goals to be achieved by all students.	1	2	3	1	2	3	4	5
b. Most students are not currently learning science well, even in the best schools.	1	2	3	1	2	3	4	5
c. Science is inextricably linked to mathematics, social sciences, and technology, and they all should be considered together when planning curriculum and instruction.	1	2	3	1	2	3	4	5
d. Science curricula for any grade range should be determined cooperatively by teachers from across the K-12 spectrum, rather than by teachers of the same grade level.	1	2	3	1	2	3	4	5
e. The nature of student understanding changes so much during elementary school that distinct learning goals should be specified for both early (K-2) and late (3-5) grades.	1	2	3	1	2	3	4	5

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14. Continued.

	A Idea conveyed clearly and explicitly			B Agreement with idea				
	Yes	Some-what	No	Disagree strongly	Disagree somewhat	Neu-tral	Agree somewhat	Agree strongly
f. Students should learn scientific "habits of mind" that explicitly include ways to assess the validity of claims and arguments.	1	2	3	1	2	3	4	5
g. Careful study of specific learning goals is an important contribution to professional development	1	2	3	1	2	3	4	5
h. Improving student understanding of science requires reducing in number and detail the science topics in the current curriculum, leaving time for more effective teaching of important ideas.	1	2	3	1	2	3	4	5
i. Identification of appropriate materials for curriculum and instruction requires detailed study of how they relate to specific learning goals	1	2	3	1	2	3	4	5
j. Science teaching should be consistent with the nature of scientific inquiry. Characteristics of scientific inquiry include valid evidence, logical reasoning, explaining data, predicting outcomes.	1	2	3	1	2	3	4	5

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Section C: Your Teaching Practices

15. Please tell us how much, in general, each of the following documents influences **what** you teach. If you teach in a school, please relate this question to how you teach students. If you are responsible for inservice, please relate this question to how you conduct inservice. Use a scale of 1 to 5, where 1 is no influence and 5 is major influence. Mark "na" for "does not apply" if the document does not exist in your state or district, or if you have not heard of or have not seen the document. *(CIRCLE ONE NUMBER FOR EACH LINE)*

	No influence	Little influence	Some influence	Significant influence	Major influence	na
a. Your district science curriculum framework/ course of study	1	2	3	4	5	0
b. Your state science curriculum framework/ course of study	1	2	3	4	5	0
c. Your state test(s)	1	2	3	4	5	0
d. Your district test(s)	1	2	3	4	5	0
e. Your current science textbook	1	2	3	4	5	0
f. Other commercially published curriculum materials	1	2	3	4	5	0
g. *Science for All Americans* (AAAS, 1989)	1	2	3	4	5	0
h. *Benchmarks for Science Literacy* (AAAS, 1993)	1	2	3	4	5	0
i. *The Content Core: Scope, Sequence & Coordination* (NSTA, 1992)	1	2	3	4	5	0
j. *National Science Education Standards* (NRC, 1995)	1	2	3	4	5	0

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16. How much, in general, does each of the following influence **what** you teach? *(CIRCLE ONE NUMBER FOR EACH LINE)*

	No influence	Little influence	Some influence	Significant influence	Major influence
a. **Your own science content background**	1	2	3	4	5
b. Your own understanding of what motivates your students	1	2	3	4	5
c. **Available laboratory facilities, equipment, and supplies**	1	2	3	4	5
d. Wishes of parents/community	1	2	3	4	5

Questions 17 & 18 and 19 & 20 ask about your experiences before and after the workshop.

17. In general, how frequently did you engage in the following activities **prior** to attending the workshop? *(CIRCLE ONE NUMBER FOR EACH LINE)*

"Prior to the workshop, I..."	Never	Rarely	Occasionally	Often	Very often
a. ...evaluated lesson plans in terms of what students will actually learn	1	2	3	4	5
b. ...participated in curriculum writing team for school or district	1	2	3	4	5
c. ...referred to outside resources for new science knowledge	1	2	3	4	5
d. Other (please specify and circle) _____	1	2	3	4	5

18. In general, how frequently do you now engage in the following activities **as a result** of attending the workshop? *(CIRCLE ONE NUMBER FOR EACH LINE)*

"As a result of the workshop, I now..."	Never	Rarely	Occasionally	Often	Very often
a. ...evaluate lesson plans in terms of what students will actually learn	1	2	3	4	5
b. ...participate in curriculum writing team for school or district	1	2	3	4	5
c. ...refer to outside resources for new science knowledge	1	2	3	4	5
d. Other (please specify and circle) _____	1	2	3	4	5

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If you teach in a school, please relate the following two questions to how you teach students. If you are responsible for inservice, please relate them to how you conduct inservice.

19. In general, how frequently did you engage in the following activities for a typical course **prior** to attending the workshop? *(CIRCLE ONE NUMBER FOR EACH LINE)*

"Prior to the workshop, I..."	**Almost Never**	**Once a month**	**2-3 times a month**	**Once a week**	**Almost every class**
a. ...used student discussion and inquiry in class	1	2	3	4	5
b. ...incorporated more hands-on activities	1	2	3	4	5
c. ...probed and addressed students' preconceptions about science topics	1	2	3	4	5
d. Other (please specify and circle) _____	1	2	3	4	5

20. In general, how frequently do you now engage in the following activities for a typical course as a **result** of attending the workshop? *(CIRCLE ONE NUMBER FOR EACH LINE)*

"As a result of the workshop, I now..."	**Almost Never**	**Once a month**	**2-3 times a month**	**Once a week**	**Almost every class**
a. ...use student discussion and inquiry in class	1	2	3	4	5
b. ...incorporate more hands-on activities	1	2	3	4	5
c. ...probe and address students' preconceptions about science topics	1	2	3	4	5
d. Other (please specify and circle) _____	1	2	3	4	5

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21. Please describe how you currently use Project 2061 materials or concepts.

22. What improvements could be made to the workshop you attended?

23. What did you find most useful about the workshop?

Thank you very much for your assistance.

Please use the enclosed envelope to return the completed questionnaire to:

Evaluation of Project 2061 (AAAS)
SRI International
BS-181
333 Ravenswood Avenue
Menlo Park, CA 94025

SURVEY OF PROJECT 2061-SPONSORED *BENCHMARKS FOR SCIENCE LITERACY* WORKSHOP

EVALUATION OF PROJECT 2061 (AAAS)

QUESTIONS? PLEASE CALL:

Viki Young (415) 859-2751

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SRI International
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Menlo Park, CA 94025

Please take a moment to read this important information before you begin the questionnaire.

This survey is being conducted for the American Association for the Advancement of Science (AAAS), as part of a larger effort to evaluate the impact of AAAS' Project 2061. This is a short survey and will take only a few minutes to complete. Project 2061 is committed to long-term science education reform, and an integral component of its reform strategy is the ***Benchmarks for Science Literacy*** **(Project 2061) workshop** you attended. Your feedback on the workshop will be extremely valuable in Project 2061's continuing efforts to support science education reform.

This survey asks specifically about the Project 2061 summer workshop in which you participated. It also may have been called the Leaders Network. All references in this survey to the Leaders Network, *Benchmarks*, or *Benchmarks for Science Literacy* workshop refer to that summer workshop.

Your responses will be **completely confidential**. Your answers to this survey will be aggregated with those of all respondents and summarized for AAAS.

We appreciate your taking some time to complete this short survey, and thank you in advance for your cooperation.

Directions

- Please read all questions and instructions carefully. Answer the questions by circling the appropriate number or writing in the answer, if requested to do so. It is important that you limit your response to one alternative for questions that direct you to "Circle One." We cannot use your answer if it is between two responses or if you change the wording of the question in any way. Please pay careful attention to the labels on scales in questions where you are asked for a rating.

- When you have finished the questionnaire, please return it to **SRI International** in the enclosed self-addressed, stamped envelope.

- Please return this survey by **Monday, February 12, 1996**.

- If you have any questions, please contact Viki Young at SRI International, (415) 859-2751.

Section A. Your Background

1. Which statement best describes your formal teaching responsibilities? *(CIRCLE ONE)*

I currently teach classes at a school (K-12 level).....	1
I conduct inservice sessions for my school or district.....	2
I am a post-secondary instructor.....	3
Other (please specify) _____	4

2. Please list the class(es) you teach and their associated grade level(s) or the inservice session(s) that you conduct.

	Class/ Inservice session	Grade level
a.	_____	_____
b.	_____	_____
c.	_____	_____
d.	_____	_____
e.	_____	_____
f.	_____	_____

3. Please estimate the percentage of students you teach who **receive free or reduce lunch**. Circle "na" if you conduct inservice and do not teach students. *(CIRCLE ONE)*

0% to 9%.....	1
10% to 19%.....	2
20% to 29%.....	3
30% to 39%.....	4
40% to 49%.....	5
50% to 74%.....	6
over 75%.....	7
na.....	8

4. **Please estimate the percentage of students in your school who are in the following categories.** *(TOTAL SHOULD ADD TO 100%)*

White	____%
African American	____%
Latino/a	____%
Asian or Pacific Islander	____%
American Indian or Alaskan Native	____%
Other	____%
Total	**100%**

5. How many full-time equivalent (FTE) years have you been teaching? Count each full-time year as 1 year, and each part-time year as the appropriate fraction of 1 year for your total experience (e.g., if you taught 2 years at full-time and 1 year at half-time, your total experience would be 2.5 FTE years.) Exclude any breaks in service.

   Number of FTE years: _____

6. How many full-time equivalent (FTE) years have you been teaching **science**? Exclude any breaks in service.

   Number of FTE years teaching **science**: _____

7. Which of the following degrees do you hold? *(CIRCLE ALL THAT APPLY)*

Degree	Major	
a. Bachelor's	Science	1
	Science Education	2
	Mathematics	3
	Math Education	4
	Other	5
b. Master's	Science	6
	Science Education	7
	Mathematics	8
	Math Education	9
	Other	10
c. Ph.D.	Science	11
	Science Education	12
	Mathematics	13
	Math Education	14
	Other	15
d. Other (please specify)		
_____		16

8. A. Please circle the number that corresponds to the total amount of time, within the **last 12 months,** that you have spent on inservice in **science or the teaching of science**. Do not include formal courses for which you received college or continuing education credit.

B. Then circle the number that corresponds to the total amount of time you have spent on inservice for these topics in the **last 3 years**, including the last 12 months. *(CIRCLE ONE NUMBER IN EACH CATEGORY)*

Hours of inservice in science or science education	A Last 12 months	B Last 3 years
None	1	1
Less than 6 hours	2	2
6 - 15 hours	3	3
16 - 35 hours	4	4
More than 35 hours	5	5

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Section B. Your Experience with Project 2061 Leaders Network Workshops

9. Which Leaders Network summer workshop(s) did you attend? *(CIRCLE ONE)*

June 1994	1
June 1995	2
Both	3

The following questions refer to your **most recent** Leaders Network summer workshop.

10. Please indicate your most important reason for attending the Leaders Network workshop. *(CIRCLE ONE)*

Believed workshop would aid in my responsibilities for science teacher training	1
Wanted to later lead workshops	2
Selected by my school or district to attend workshop	3
Wanted to enhance my science teaching skills	4
Particularly interested in learning about Project 2061 and *Benchmarks for Science Literacy*	5
Anticipated that workshop content would be applicable in curriculum development with my school or district	6
Invited by Project 2061 staff	7
Other (please specify) _____	8

11. Please rate each of the following potential outcomes of the workshop in terms of its benefit to your work, using a scale of 1 to 5, where 1 represents no benefit and 5 major benefit. *(CIRCLE ONE NUMBER FOR EACH LINE)*

	No benefit	Little benefit	Some benefit	Significant benefit	Major benefit
a. Increased familiarity with Project 2061 reform and science literacy concepts	1	2	3	4	5
b. Developed skills in using *Benchmarks for Science Literacy* to analyze curriculum materials	1	2	3	4	5
c. Gained confidence in analyzing curriculum materials	1	2	3	4	5
d. Acquired new ideas and methods for implementing inquiry-based lessons	1	2	3	4	5
e. Gained appreciation for working with teachers across multiple grade levels	1	2	3	4	5
f. Increased science knowledge	1	2	3	4	5
g. Discovered resources for augmenting science knowledge	1	2	3	4	5
h. Other (please specify and circle) _____	1	2	3	4	5

12. Overall, how beneficial was the workshop to your work? *(CIRCLE ONE)*

No benefit	Little benefit	Some benefit	Significant benefit	Major benefit
1	2	3	4	5

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13 A. The *Benchmarks* workshop that you attended attempted to convey certain ideas about science education. Were the following ideas conveyed clearly and explicitly during the workshop?

B. To what extent do you agree or disagree with each idea?

(CIRCLE ONE NUMBER IN COLUMN A AND ONE NUMBER IN COLUMN B FOR EACH LINE)

	A Idea conveyed clearly and explicitly			B Agreement with idea				
	Yes	Some-what	No	Disagree strongly	Disagree somewhat	Neu-tral	Agree somewhat	Agree strongly
a. Changes in the education system should be driven by important, specific goals to be achieved by all students.	1	2	3	1	2	3	4	5
b. Most students are not currently learning science well, even in the best schools.	1	2	3	1	2	3	4	5
c. Science is inextricably linked to mathematics, social sciences, and technology, and they all should be considered together when planning curriculum and instruction.	1	2	3	1	2	3	4	5
d. Science curricula for any grade range should be determined cooperatively by teachers from across the K-12 spectrum, rather than by teachers of the same grade level.	1	2	3	1	2	3	4	5
e. The nature of student understanding changes so much during elementary school that distinct learning goals should be specified for both early (K-2) and late (3-5) grades.	1	2	3	1	2	3	4	5

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13. Continued

	A Idea conveyed clearly and explicitly			B Agreement with idea				
	Yes	Some-what	No	Disagree strongly	Disagree somewhat	Neu-tral	Agree somewhat	Agree strongly
f. Students should learn scientific "habits of mind" that explicitly include ways to assess the validity of claims and arguments.	1	2	3	1	2	3	4	5
g. Careful study of specific learning goals is an important contribution to professional development.	1	2	3	1	2	3	4	5
h. Improving student understanding of science requires reducing in number and detail the science topics in the current curriculum, leaving time for more effective teaching of important ideas.	1	2	3	1	2	3	4	5
i. Identification of appropriate materials for curriculum and instruction requires detailed study of how they relate to specific learning goals.	1	2	3	1	2	3	4	5
j. Science teaching should be consistent with the nature of scientific inquiry. Characteristics of scientific inquiry include valid evidence, logical reasoning, explaining data, predicting outcomes.	1	2	3	1	2	3	4	5

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Section C. Your Teaching Practice

14. Please tell us how much, in general, each of the following documents influences **what** you teach. If you teach in a school, please relate this question to how you teach students. If you are responsible for inservice, please relate this question to how you conduct inservice. Use a scale of 1 to 5, where 1 is no influence and 5 is major influence. Mark "na" for "does not apply" if the document does not exist in your state or district, or if you have not heard of or have not seen the document. *(CIRCLE ONE NUMBER FOR EACH LINE)*

	No influence	Little influence	Some influence	Significant influence	Major influence	na
a. **Your district science curriculum framework/ course of study**	1	2	3	4	5	0
b. Your state science curriculum framework/ course of study	1	2	3	4	5	0
c. **Your state test(s)**	1	2	3	4	5	0
d. Your district test(s)	1	2	3	4	5	0
e. **Your current science textbook**	1	2	3	4	5	0
f. Other commercially published curriculum materials	1	2	3	4	5	0
g. ***Science for All Americans*** **(AAAS, 1989)**	1	2	3	4	5	0
h. *Benchmarks for Science Literacy* (AAAS, 1993)	1	2	3	4	5	0
i. ***The Content Core: Scope, Sequence & Coordination*** **(NSTA, 1992)**	1	2	3	4	5	0
j. *National Science Education Standards* (NRC, 1995)	1	2	3	4	5	0

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15. How much, in general, does each of the following influence **what** you teach? *(CIRCLE ONE NUMBER FOR EACH LINE)*

	No influence	Little influence	Some influence	Significant influence	Major influence
a. Your own science content background	1	2	3	4	5
b. Your own understanding of what motivates your students	1	2	3	4	5
c. Available laboratory facilities, equipment, and supplies	1	2	3	4	5
d. Wishes of parents/ community	1	2	3	4	5

Questions 16 & 17 and 18 & 19 ask about your experiences before and after the workshop.

16. In general, how frequently did you engage in the following activities **prior** to attending the workshop? *(CIRCLE ONE NUMBER FOR EACH LINE)*

"Prior to the workshop, I..."	Never	Rarely	Occasionally	Often	Very often
a. ...was critical of lesson plans in terms of what students will actually learn	1	2	3	4	5
b. ...participated in curriculum writing team for school or district	1	2	3	4	5
c. ...referenced outside resources for new science knowledge	1	2	3	4	5
d. Other (please specify and circle) _____	1	2	3	4	5

17. In general, how frequently do you now engage in the following activities **as a result** of attending the workshop? *(CIRCLE ONE NUMBER FOR EACH LINE)*

"As a result of the workshop, I now..."	Never	Rarely	Occasionally	Often	Very often
a. ...am critical of lesson plans in terms of what students will actually learn	1	2	3	4	5
b. ...participate in curriculum writing team for school or district	1	2	3	4	5
c. ...reference outside resources for new science knowledge	1	2	3	4	5
d. Other (please specify and circle) _____	1	2	3	4	5

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If you teach in a school, please relate the following two questions to how you teach students. If you are responsible for inservice, please relate them to how you conduct inservice.

18. In general, how frequently did you engage in the following activities for a typical course **prior** to attending the workshop? *(CIRCLE ONE NUMBER FOR EACH LINE)*

"Prior to the workshop, I..."	**Almost Never**	**Once a month**	**2-3 times a month**	**Once a week**	**Almost every class**
a. ...used student discussion and inquiry in class	1	2	3	4	5
b. ...incorporated hands-on activities	1	2	3	4	5
c. ...probed and addressed students' preconceptions about science topics	1	2	3	4	5
d. Other (please specify and circle) _____	1	2	3	4	5

19. In general, how frequently do you now engage in the following activities for a typical course **as a result** of attending the workshop? *(CIRCLE ONE NUMBER FOR EACH LINE)*

"As a result of the workshop, I now..."	**Almost Never**	**Once a month**	**2-3 times a month**	**Once a week**	**Almost every class**
a. ...use student discussion and inquiry in class	1	2	3	4	5
b. ...incorporate hands-on activities	1	2	3	4	5
c. ...probe and address students' preconceptions about science topics	1	2	3	4	5
d. Other (please specify and circle) _____	1	2	3	4	5

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Section D. Your Training Activity

20. How well do you feel the Leaders Network summer workshop prepared you to train colleagues in Project 2061 reform and science literacy concepts, *Science for All Americans* tools, and *Benchmarks* tools? Please use a scale of 1 to 5, where 1 is not at all and 5 is very well. *(CIRCLE ONE)*

Not at all	Poorly	Adequately	Well	Very well
1	2	3	4	5

21. Have you used a Leader's Guide? *(CIRCLE ONE)*

Yes..... 1

No..... 2 → ***IF NO, SKIP TO QUESTION 25***

22. For what purpose(s) did you use the Leader's Guide? *(CIRCLE ALL THAT APPLY)*

Preparation to give training.....	1
Preparation for class/lesson plan preparation.....	2
Personal reference.....	3
Shared/lent to colleague.....	4
Other (please specify): _____	5

23. Which part(s) of the Leader's Guide did you use? *(CIRCLE ALL THAT APPLY)*

Selected Leader's Guide Components	
"Planning a *SFAA/ Benchmarks* Workshop".....	1
"Obtaining Materials and Supplies".....	2
"Introductory Modules".....	3
"Background Modules: Project 2061, *SFAA, Benchmarks*".....	4
"Activity Modules: K-12 Progression of Understanding".....	5
"Activity Modules: Conceptual Connections".....	6
"Activity Modules: Using *Benchmarks for Science Literacy*".....	7
"Conclusion/ Evaluation Modules".....	8
Benchmarks on Disk.....	9
Sample workshop plans.....	10
Handouts and/ or Slides.....	11
Other (please specify): _____	12

24. Overall, how useful do you think the Leader's Guide is to your work? *(CIRCLE ONE)*

Not useful at all	Somewhat useful	Significant contribution	Dominant source	Depend on it completely
1	2	3	4	5

25. Have you informally shared with your colleagues knowledge gained at the Leaders Network workshop, (e.g., through hallway or lunchroom conversation)? *(CIRCLE ONE)*

Yes..... 1

No..... 2

26. Have you conducted formal training sessions on Project 2061 or *Benchmarks for Science Literacy*? *(CIRCLE ONE)*

Yes..... 1

No..... 2 → ***IF NO, SKIP TO QUESTION 28***

27. How many sessions have you offered in the following contexts? *(CIRCLE ONE NUMBER FOR EACH LINE)*

How many sessions have you offered:							
In your school	0	1	2	3	4	5	> 5
In your district	0	1	2	3	4	5	> 5
Outside your district	0	1	2	3	4	5	> 5

28. Do you have plans to conduct formal training in the future?

Yes..... 1

No..... 2

29. Do you have training sessions scheduled?

Yes..... 1

No..... 2

30. If you have not offered training sessions, please comment on what has prevented you from conducting training sessions and/or why you have not previously been interested in training.

_____

_____

_____

_____

_____

31. What would be or have been major incentives for you to conduct training sessions on Project 2061 or *Benchmarks for Science Literacy*?

_____

_____

_____

_____

_____

Section E. Conclusion

32. What improvements could be made to the Leaders Network workshop you attended?

_____

_____

_____

_____

_____

33. What did you find most useful about the Leaders Network summer workshop?

_____

_____

_____

_____

_____

Thank you very much for your assistance.

Please use the enclosed envelope to return the completed questionnaire to:

Evaluation of Project 2061 (AAAS)
SRI International
BS-181
333 Ravenswood Avenue
Menlo Park, CA 94025

SURVEY OF PROJECT 2061-SPONSORED *BENCHMARKS FOR SCIENCE LITERACY* WORKSHOP

EVALUATION OF PROJECT 2061 (AAAS)

QUESTIONS? PLEASE CALL:

Viki Young (415) 859-2751

Please use the enclosed envelope to return the completed questionnaire to:

Evaluation of Project 2061 (AAAS)
SRI International
BS-181
333 Ravenswood Avenue
Menlo Park, CA 94025

Please take a moment to read this important information before you begin the questionnaire.

This survey is being conducted for the American Association for the Advancement of Science (AAAS), as part of a larger effort to evaluate the impact of AAAS' Project 2061. Project 2061 is committed to long-term science education reform, and an integral component of its reform strategy is the ***Benchmarks for Science Literacy*** **(Project 2061) workshop** you attended. Your feedback on the workshop will be extremely valuable in Project 2061's continuing efforts to support science education reform.

This survey asks specifically about the Teacher Education workshop(s) you attended. It may have also been referred to as a *Benchmarks for Science Literacy* workshop. All references in this survey to the *Benchmarks* workshop refer to that Teacher Education workshop.

Your responses will be **completely confidential**. Your answers to this survey will be aggregated with those of all respondents and summarized for AAAS.

We appreciate your taking some time to complete this short survey, and thank you in advance for your cooperation.

Directions

- Please read all questions and instructions carefully. Answer the question by circling the appropriate number or writing the answer, if requested to do so. It is important that you limit your response to one alternative for questions that direct you to "Circle One." We cannot use your answer if it is between two responses or if you change the wording of the question in any way. Please pay careful attention to the labels on scales in questions where you are asked for a rating.

- When you have finished the questionnaire, please return it to **SRI International** in the enclosed self-addressed, stamped envelope.

- Please return this survey by **Monday, February 12, 1996**.

- If you have any questions, please contact Viki Young at SRI International, (415) 859-2751.

Section A: Your Background

1. Please provide your title or position and circle the number that corresponds to the type of institution at which you teach.

Title or position: _____

Type of Institution	Circle one	
School	1	} *IF 1-4, SKIP TO QUESTION 3*
District	2	
County	3	
State	4	
Institution of Higher Education	5	

2. Circle the number that corresponds to your faculty appointment and write in your department.

Faculty Appointment	Circle one	Department
Arts	1	_____
Science	2	_____
Education	3	_____
Other (please specify) _____	4	_____

3. Please provide the title(s) of the class(es) that you are teaching this academic year. If you are currently involved in preparing prospective teachers, please indicate the subject and (if known) the levels they are being prepared to teach, e.g., "science" and "middle school."

Class title(s)	Subject(s) teachers are being prepared to teach	Level(s) teachers are being prepared to teach
a.	a.	a.
b.	b.	b.
c.	c.	c.
d.	d.	d.
e.	e.	e.
f.	f.	f.

Section B: Your Involvement and Experiences with *Benchmarks for Science Literacy* (Project 2061-sponsored) Workshops

4. Which Teacher Educator/*Benchmarks* workshop(s) did you attend? *(CIRCLE ALL THAT APPLY)*

October 1994	1
August 1995	2
September 1995	3

The following questions refer to your **most recent** Teacher Educator/*Benchmarks* workshop.

5. Please indicate your most important reason for attending this Teacher Educator/*Benchmarks* workshop. *(CIRCLE ONE)*

Invited to attend	1
Want to improve teachers' preservice or inservice science education	2
Project 2061 concepts and/ or initiatives are closely associated with my research	3
Particularly interested in learning about Project 2061 and *Benchmarks for Science Literacy*	4
Involved in curriculum development for my institution, or for a school, school district or state agency	5
Was/ am participating in State Systemic Initiative (SSI) or other education reform project	6
Other (please specify and circle) _____	7

6. Please rate each of the following potential outcomes of the workshop in terms of its benefit to your work, using a scale of 1 to 5, where 1 is no benefit and 5 is major benefit. *(CIRCLE ONE NUMBER FOR EACH LINE)*

	No benefit	Little benefit	Some benefit	Significant benefit	Major benefit
a. Increased familiarity with Project 2061 reform and science literacy concepts	1	2	3	4	5
b. Developed skills in using *Benchmarks for Science Literacy* to analyze curriculum materials	1	2	3	4	5
c. Gained confidence in analyzing curriculum materials	1	2	3	4	5
d. Acquired new ideas and methods for implementing inquiry-based lessons	1	2	3	4	5
e. Gained appreciation for working with teachers across multiple grade levels	1	2	3	4	5
f. Increased science knowledge	1	2	3	4	5
g. Discovered resources for augmenting science knowledge	1	2	3	4	5
h. Other (please specify and circle) _____	1	2	3	4	5

7. Overall, how beneficial was the workshop to your work? *(CIRCLE ONE)*

No benefit	Little benefit	Some benefit	Significant benefit	Major benefit
1	2	3	4	5

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8. A. The *Benchmarks* workshop that you attended attempted to convey certain ideas about science education. Were the following ideas conveyed clearly and explicitly during the workshop?

B. To what extent do you agree or disagree with each idea?

(CIRCLE ONE NUMBER IN COLUMN A AND ONE NUMBER IN COLUMN B FOR EACH LINE)

	A Idea conveyed clearly and explicitly			B Agreement with idea				
	Yes	Some-what	No	Disagree strongly	Disagree somewhat	Neu-tral	Agree somewhat	Agree strongly
a. Changes in the education system should be driven by important, specific goals to be achieved by all students.	1	2	3	1	2	3	4	5
b. Most students are not currently learning science well, even in the best schools.	1	2	3	1	2	3	4	5
c. Science is inextricably linked to mathematics, social sciences, and technology, and they all should be considered together when planning curriculum and instruction.	1	2	3	1	2	3	4	5
d. Science curricula for any grade range should be determined cooperatively by teachers from across the K-12 spectrum, rather than by teachers of the same grade level.	1	2	3	1	2	3	4	5
e. The nature of student understanding changes so much during elementary school that distinct learning goals should be specified for both early (K-2) and late (3-5) grades.	1	2	3	1	2	3	4	5

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8. Continued

	A Idea conveyed clearly and explicitly			B Agreement with idea				
	Yes	Some-what	No	Disagree strongly	Disagree somewhat	Neu-tral	Agree somewhat	Agree strongly
f. Students should learn scientific "habits of mind" that explicitly include ways to assess the validity of claims and arguments.	1	2	3	1	2	3	4	5
g. Careful study of specific learning goals is an important contribution to professional development.	1	2	3	1	2	3	4	5
h. Improving student understanding of science requires reducing in number and detail the science topics in the current curriculum, leaving time for more effective teaching of important ideas.	1	2	3	1	2	3	4	5
i. Identification of appropriate materials for curriculum and instruction requires detailed study of how they relate to specific learning goals.	1	2	3	1	2	3	4	5
j. Science teaching should be consistent with the nature of scientific inquiry. Characteristics of scientific inquiry include valid evidence, logical reasoning, explaining data, predicting outcomes.	1	2	3	1	2	3	4	5

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Section C: Your Teaching Practices

9. A. Please indicate whether you use the following documents in your work.
   B. How important do you consider each of them? Circle "na" if you answered "no" in A above.
   C. Do you encourage your student teachers to study any of these documents? *(IF YOU DO NOT TEACH PROSPECTIVE TEACHERS, CIRCLE "na" IN COLUMN C ONLY)*

(CIRCLE ONE NUMBER FOR EACH LINE IN EACH CATEGORY)

Document	A: Use these for own purposes		B: Importance to you				C: Encourage student teachers to study these		
	Yes	No	Low	Med	High	na	Yes	No	na
a. Relevant or exemplary district science curriculum frameworks	1	2	1	2	3	0	1	2	0
b. State science curriculum framework or standards	1	2	1	2	3	0	1	2	0
c. State or district tests	1	2	1	2	3	0	1	2	0
d. Science textbooks	1	2	1	2	3	0	1	2	0
e. Other commercially published curriculum materials	1	2	1	2	3	0	1	2	0
f. *Science for All Americans* (AAAS, 1989)	1	2	1	2	3	0	1	2	0
g. *Benchmarks for Science Literacy* (AAAS, 1993)	1	2	1	2	3	0	1	2	0
h. *The Content Core: Scope, Sequence & Coordination* (NSTA, 1992)	1	2	1	2	3	0	1	2	0
i. *National Science Education Standards* (NRC, 1995)	1	2	1	2	3	0	1	2	0

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Questions 10 & 11 and 12 & 13 ask about your experiences before and after the workshop.

10. In general, how frequently did you engage in the following activities **prior** to attending the workshop? If you do not teach prospective teachers, please circle "na" for **a, b, and c only**
(CIRCLE ONE NUMBER FOR EACH LINE)

"Prior to the workshop, I..."	Never	Rarely	Occasionally	Often	Very often	na
a. ...evaluated prospective teachers' lesson plans in terms of what students will actually learn	1	2	3	4	5	0
b. ...referred my student teachers to *Benchmarks for Science Literacy*	1	2	3	4	5	0
c. ...referred my student teachers to *Science for All Americans*	1	2	3	4	5	0
d. ...evaluated my own lesson plans in terms of what students will actually learn	1	2	3	4	5	0
e. ...was reflective about pedagogy	1	2	3	4	5	0
f. Other (please specify and circle) _____	1	2	3	4	5	0

11. In general, how frequently do you now engage in the following activities **as a result** of attending the workshop? If you do not teach prospective teachers, please circle "na" for **a, b, and c** only.
(CIRCLE ONE NUMBER FOR EACH LINE)

"As a result of the workshop, I now..."	Never	Rarely	Occasionally	Often	Very often	na
a. ...evaluate prospective teachers' lesson plans in terms of what students will actually learn	1	2	3	4	5	0
b. ...refer my student teachers to *Benchmarks for Science Literacy*	1	2	3	4	5	0
c. ...refer my student teachers to *Science for All Americans*	1	2	3	4	5	0
d. ...evaluate my own lesson plans in terms of what students will actually learn	1	2	3	4	5	0
e. ...am reflective about pedagogy	1	2	3	4	5	0
f. Other (please specify and circle) _____	1	2	3	4	5	0

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12. In general, how frequently did you engage in the following activities for a typical course **prior** to attending the workshop? *(CIRCLE ONE NUMBER FOR EACH LINE)*

"Prior to the workshop, I..."	Almost Never	Once a month	2-3 times a month	Once a week	Almost every class
a. ...used *Science for All Americans* and *Benchmarks for Science Literacy* in class	1	2	3	4	5
b. ...used student discussion and inquiry in class	1	2	3	4	5
c. ...incorporated hands-on activities in my classes	1	2	3	4	5
d. Other (please specify and circle) _____	1	2	3	4	5

13. In general, how frequently do you now engage in the following activities for a typical course **as a result** of attending the workshop? *(CIRCLE ONE NUMBER FOR EACH LINE)*

"As a result of the workshop, I now..."	Almost Never	Once a month	2-3 times a month	Once a week	Almost every class
a. ...use *Science for All Americans* and *Benchmarks for Science Literacy* in class	1	2	3	4	5
b. ...use student discussion and inquiry in class	1	2	3	4	5
c. ...incorporate hands-on activities in my classes	1	2	3	4	5
d. Other (please specify and circle) _____	1	2	3	4	5

14. What improvements could be made to the workshop you attended?

_____

_____

_____

_____

_____

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15. What did you find most useful about the workshop you attended?

16. Based on your experience, please share your thoughts on the role Project 2061 plays in preservice science teacher education.

Thank you very much for your assistance.

Please use the enclosed envelope to return the completed questionnaire to:

Evaluation of Project 2061 (AAAS)
SRI International
BS-181
333 Ravenswood Avenue
Menlo Park, CA 94025